

important to the region's recreational and commercial fisheries, including: Pink Shrimp (Penaeus duorarum), Stone Crab (Menippe mercenaria), Spiny Lobster (Panulirus argus), jacks (family Caranigadae), jewfish (Epinepelus itajara), grunts (family Pomadasyidae), grouper (Dpinepelus spp.), seabass (family Serranidae), snapper (Lutjanus spp.), mullet (family Mugilidae), Red Drum (Sciaenops ocellata), Ladyfish (Elops saurus), Spotted Sea Trout (Cynoscion nebulus) and Menhaden (Brevoortia patronus) (Florida DNR, 1991c).

B. Fish Species Common to Salt Pond Communities

Fish species frequently reported to occur include the Sheepshead Minnow (Cyprinodon variegatus), Killifish (Fundulus spp.), Rainwater Killifish (Lucania parva), Diamond Killifish (Adenia xenica), Mosquitofish (Gambusia affinis), and Sailfin Molly (Poecilia latipinna).

C. Fish Species Common to Seagrass Bed Communities

The seagrass beds are transitional habitats between the coral reef and mangrove habitats. As such, they are important to many species of both ecosystems. They provide abundant food and shelter for a myriad species of fish, sea turtles, and invertebrates. They represent the richest nursery and feeding grounds in South Florida's coastal waterways. In addition to representing a primary resource for grazers, seagrasses provide vast amounts of energy via detritus that may cycle internally or be exported to mangrove or coral reef communities.

Faunal constituents of the marine grassbed community include a diversity of microscopic zooplankton, epiphytic biota, pelagic invertebrates, fishes and mammals. A large number of birds feed extensively in shallow seagrass meadows.

Conspicuous among the epibenthic invertebrates found in seagrass beds are the Queen Conch (Strombus gigas), the Spiny Lobster (Panulirus argus), the Bahamian Starfish (Oreaster reticulata), and numerous sea urchins, most notably Lytechinus variegatus and Tripneustes ventricoccus. Numerous epiphytic invertebrates glean food from seagrass areas by preying on the algae that grow on the leaves of seagrasses. Principal among these are a variety of gastropods. Many invertebrates, including the Pink Shrimp (Penaeus duorarum) and the Spiny Lobster, utilize seagrass meadows for nurseries.

Diverse and abundant fish faunas also inhabit seagrass communities. While few, if any, of the many permanent residents are of direct commercial value, these seagrass ecosystems are important nurseries and feeding areas for such species. These include the Sea Bream (Archosargus rhomboides), the Sheepshead (A. probatocephalus), the Gag Grouper (Mycteroperca microlepis), the Redfish (Sciaenops ocellata), the Gray Snapper (Lutjanus griseus), the Lane Snapper (L. synagris), the Dog Snapper (L. jocu), the Mutton Snapper (L. annalis), the Yellowtail Snapper (Ocyurus chrysurus), and the Spotted Seatrout (Cynoscion nebulosus). Other fish that extensively use seagrasses as nursery areas are:

Pinfish	<u>Lagodon rhomboides</u>
Spot	<u>Leiostomus xanthurus</u>
Silver Perch	<u>Bairdiella chrysura</u>
Pigfish	<u>Orthopristis chrysoptera</u>

White Grunt	<u>Haemulon plumeri</u>
Ocean Surgeon	<u>Acanthurus bahianus</u>
Doctorfish	<u>Acanthurus chirurgus</u>
Spotted Goatfish	<u>Pseudupeneus maculatus</u>
Yellow Goatfish	<u>Mulloidichthys martinicus</u>
Bucktooth Parrotfish	<u>Sparisoma radians</u>
Redtail Parrotfish	<u>S. chrysopterygum</u>
Stoplight Parrotfish	<u>S. viride</u>
Redfin Parrotfish	<u>S. rubripine</u>
Striped Parrotfish	<u>Scarus croicensis</u>
Rainbow Parrotfish	<u>S. guacamaia</u>
Midnight Parrotfish	<u>S. coeruleus</u>
Emerald Parrotfish	<u>Nicholsina usta.</u>

Several sportfishing species, most notably the Tarpon (Megalops atlanticus), Bonefish (Albula vulpes) and Permit (Trachinotus falcatus), depend upon seagrass systems.

In areas where seagrass meadows abut coral reefs, many prominent species of reef fish move into seagrass areas to feed at night. Principal among them are members of the families Pomadasysidae, Lutjanidae, and Holocentridae.

D. Fish Species Common to Coral Communities

Coral reef systems provide protection and shelter for colorful and diverse macrofauna, including small shrimp, crabs, fish and several species of lobsters. Many species, especially the larger predators, are important species for local fisheries. Hardbottom communities are valuable nursery areas for many invertebrates and fishes of both the patch reef and seagrass communities, providing microhabitats for many juvenile fishes.

Larger predators of reef communities include fishes that prey upon invertebrates and smaller individuals of their own kind (see Table 3.17). The most frequently observed larger predators on the reef include the Barracuda (Sphyrna barracuda) and Moray Eel (Gymnothorax spp.) (Florida DNR, 1991c).

3.14.2 Existing Commercial, Recreational or Conservation Uses of Fisheries

Sportfishing and commercial fishing are major components of the Florida Keys' economy. Common saltwater sportfishing species include:

sailfish	drum	Spanish mackerel
bluefish	redfish	tarpon
sheepshead	amberjack	flounder
sea trout	dolphin	pompano
grouper	king mackerel	dolphin
		snapper

Major commercial fisheries include the spiny lobster, pink shrimp and conch fisheries.

Commercial fishing landings, including shellfish, for Monroe County from 1984 to 1989 are summarized as follows (National Marine Fisheries Service, 1984-1989):

<u>Year</u>	<u>Total lbs.</u>	<u>Spiny Lobster (lbs.)</u>	<u>Pink Shrimp (lbs.)</u>
1984	27,942,934	6,011,531	10,730,878
1985	24,977,169	5,421,524	10,544,220
1986	21,383,480	4,332,028	7,183,867
1987	15,018,369	5,467,353	4,552,920
1988	15,021,475	5,768,592	2,737,501
1989	12,945,763	2,167,295	2,426,154.

3.14.3 Known Problems Related to Fisheries and the Potential for Conservation, Use and Protection of Fisheries

A. Problems and Solutions Identified by the Marine Fisheries Commission

The Marine Fisheries Commission (MRC) is responsible for managing and preserving Florida's renewable marine fishery resources and enhancement of the marine and estuarine environments (FIMC, 1991). The Marine Fisheries Commission has recently summarized issues of particular concern in the Keys as follows (IMC, 1991):

"Issues of particular concern include the need for comprehensive and coherent fishery management within the [Florida Keys National Marine] Sanctuary, protected species management, and fishery habitat preservation and restoration. One solution would be to abandon species-by-species management of marine resources and consider an ecosystem approach accommodating commercial and recreational uses and incorporating necessary protection for certain species and their habitats. Very important in this process is the need for consistent regulations within the Sanctuary boundaries, including both state and federal waters. Currently, the Commission is working very closely with the federal fishery management councils to achieve consistent management of a number of significant Keys resources including corals, tropical fish and other invertebrates, sponges, and certain commercially and recreationally important fish species, including the declining shark populations off Florida."

B. Problems and Research Needs Identified by the Division of Marine Resources

The Division of Marine Resources (DMR) is responsible for managing the marine resources of the State of Florida. DMR has identified several issues and related recommended actions relative to marine resources of the Florida Keys (Florida DNR, 1991e). These are summarized as follows (Florida DNR, 1991e):

Over-Collection of Ornamental Reef Fish and Invertebrates

Over-collecting of colorful juvenile grazers for the aquarium trade and by private individuals for aquaria is expected to shift the ecological balance of the reef, either abruptly or gradually, from a community dominated by slow-growing hard corals to a community

Table 3.17

Common Fish Species of Keys' Coral Reefs

Common Name	Species Name
Outer Reef	
Creole Wrasse	<i>Clepticus parrai</i>
Blue Chromis	<i>Chromis cyanea</i>
Brown Chromis	<i>Chromis multilineata</i>
Rock Beauty	<i>Holacanthus tricolor</i>
Parrotfish	<i>Scarus spp.</i>
Hogfish	<i>Lachnolaimus maximus</i>
Sargeant Major	<i>Abedefduf saxatilis</i>
Bluehead	<i>Thalassoma bifasciatum</i>
Striped Grunt	<i>Haemulon striatum</i>
Smallmouth Grunt	<i>Haemulon chrysargyreum</i>
Bluestriped Grunt	<i>Haemulon scius</i>
French Grunt	<i>Haemulon flavolineatum</i>
Spanish Grunt	<i>Haemulon macrostomum</i>
Grey Angelfish	<i>Pomacanthus arcuatus</i>
Grey Snapper	<i>Lutjanus griseus</i>
Glassy Sweeper	<i>Pempheris schombbergi</i>
Porkfish	<i>Anisotremus virginicus</i>
Bicolor Damselfish	<i>Pomocentrus partitus</i>
Flamefish	<i>Apogon maculatus</i>
Squirrelfish	<i>Holocentrus ascensionis</i>
Pearly Razorfish	<i>Hemipteronotus novacula</i>
Seminole Goby	<i>Microgobius carri</i>
Slendor Mojarra	<i>Eucinostomus pseudogula</i>
Eyed Flounder	<i>Bothus ocellatus</i>
Ballyroo	<i>Hemiramphus brasiliensis</i>
Scaled Sardine	<i>Harengula pensacolae</i>
Lane Snapper	<i>Lutjanus synagris</i>
Yellow Stingray	<i>Urolophus jamaicensis</i>
Gag Grouper	<i>Mycteroperca microlepis</i>
Nassau Grouper	<i>Epinephelus striatus</i>
Snowy Grouper	<i>Epinephelus nireatus</i>
Jewfish	<i>Epinephelus itajara</i>
Yellowtail Snapper	<i>Ocyurus chrysurus</i>
Barracuda	<i>Sphyraena barracuda</i>
Spanish Hogfish	<i>Bodianus rufus</i>
Patch Reef	
Sergeant Major	<i>Abedefduf saxatilis</i>
Bluehead	<i>Thalassoma bifasciatum</i>
Parrotfish	<i>Scarus spp.</i>
French Angelfish	<i>Pomocanthus paru</i>
Blue Tang	<i>Acanthurus coeruleus</i>
Bluestriped Grunt	<i>Haemulon sciurus</i>
Black Grouper	<i>Mycteroperca bonaci</i>
Gag Grouper	<i>Mycteroperca microlepis</i>
Nassu Grouper	<i>Epinephelus striatus</i>
Snowy Grouper	<i>Epinephelus nireatus</i>
Jewfish	<i>Epinephelus itajara</i>
Yellowtail Snapper	<i>Ocyurus chrysurus</i>
Barracuda	<i>Sphyraena barracuda</i>
Spanish Hogfish	<i>Bodianus rufus</i>

dominated by fast-growing species such as macroalgae and octocorals. Removal of these organisms also reduces the populations of colorful fish from the reef.

Fish Trapping

Over-collecting of adult grazers for market is expected to have consequences similar to those described for juvenile grazers above.

Overfishing of Commercial Sponges

Overfishing of sponges in the Keys is suspected by biologists. Data are not available to document the reduction of stocks. Sponge fishing by sponge hook allows for a much lower percentage of sponge regeneration than sponge fishing by cutting.

Over-Collection of Large, Colorful Slow-Moving Invertebrates

Anecdotal evidence suggests a decline in populations of several species of echinoderms and mollusks, such as the Bahama starfish, the queen conch and other large ornamental echinoderms and gastropods. Existing collection limits for the few species now protected are probably inadequate.

Overcapitalization of Fisheries

More lobster traps are permitted now than at any time previously. Approximately 200,000 traps, or one-quarter the number now being deployed can efficiently trap the same number of lobsters. Adverse impacts of this situation include: reduction in the potential catch by killing sublegal stages of lobsters; more ghost traps that are lost but which still trap and kill lobsters; more physical damage by traps to coral and seagrass beds and potential snares to marine turtles and manatees; and increased impacts of a greater number of boats employed to transport and fish the traps.

Mangrove Pruning

Research is needed to provide information regarding the impacts of trimming on mangroves, particularly red mangroves.

Degradation of Nearshore Habitats

Changes in nearshore habitats, particularly nutrification and siltation, could have adverse consequences for numerous fish and shellfish now common in the Florida Keys. Research is needed on habitat requirements and monitoring of the abundance fluctuations of juveniles in these areas in order to develop better management objectives.

Refugia

No-collecting zones are needed to: provide refuge for over-collected species; for non-consumptive public recreational use of undisturbed marine environments; and for scientific use to provide natural baseline information on species and communities.

Eutrophication

Research is needed to understand the cycling of nutrients in seagrass and coral reef communities.

Seagrass Health in Florida Bay

Research is needed into the decline of seagrasses in Florida Bay. These seagrass beds are major nursery habitats for spiny lobsters, pink shrimp, spotted sea trout, and numerous other fish and invertebrates.

Organic Chemical and Heavy Metal Contamination

Numerous sources of organic chemicals and heavy metal pollutants exist that could adversely affect marine communities. Special management to protect marine communities from releases of these contaminants into nearshore waters.

Catastrophic Declines in Populations of Reef Animals

Research is needed to document the correlation between declines in long-spined urchin, staghorn coral, and false coral populations with specific point and non-point sources of contamination.

Physical Damage to Corals

As many as 1,000 persons per day may visit a single reef in the Key. Management techniques are needed to mitigate or reduce physical damage to corals caused by these visitors. Research is needed to determine the number of visitors that a reef can support annually and still be ecologically viable.

Propeller Damage to Seagrasses

Management techniques are needed to reduce propeller damage to seagrasses, particularly in Florida Bay and shallow-water areas throughout the Keys.

Artificial Reefs

Research is needed regarding artificial reefs to determine optimal structure, construction materials and site conditions which favor growth of sessile reef plants and animals that provide habitats for motile reef invertebrates and fish.

C. Problems and Solutions Identified by the Florida Game and Fresh Water Fish Commission

The Florida Game and Fresh Water Fish Commission (FGFWFC) is responsible for managing freshwater aquatic life and wild animal life and their habitat to perpetuate a diversity of species with densities and distributions that provide sustained ecological, recreational, scientific, educational, aesthetic and economic benefits" (IMC, 1991). The major issues of concern to the FGFWFC with regard fisheries in the Florida Keys National Marine Sanctuary are as follows:

Propeller Damage to Seagrass Beds

- Problem: more boats, bigger boats, continued permitting of docks in areas lacking deep-water access, commercial operators taking short-cuts, inexperienced recreational operators unable/unwilling to read the water all resulting in an alarming cumulative loss of habitat.
- Solution: (a) adopt the Florida Keys' Audubon Society's Four-Point Program to Reduce Boating Impacts to protect important locations (including establishment of buffer zones, no-motor zones, and closed areas;

- improved and expanded channel marking, increased public education, and increased enforcement;
- (b) post more bird nesting areas and critical wildlife areas;
- (c) restrict thrillcraft to designated zones; and
- (d) prohibit new marinas and expanded marinas.

Loss of Wetlands Habitat and Mangrove Trimming

- Problem: loss of wetlands (salt marshes and fringing mangroves continue to be filled and cut for development.
- Solution:
- (a) prohibit placement of non-water-dependent structures in tidal wetlands; and
 - (b) severely restrict removal/cutting/trimming of mangroves, accompanied by funding for increased enforcement.

D. Problems and Solutions Specifically Related to the Two-Day Lobster Sport-Fishing Season Identified by the Monroe County Board of County Commissioners and the Marine Resources Commission

Particular attention has been recently paid to the lobster fishery by the Monroe County BOCC and the MRC. Both groups have determined that the changes to the existing regulations are to: protect the lobster fishery from overfishing during the two-day season; reduce the physical impacts of the intense period of recreational boating and diving on seagrass and coral communities; and, reduce the impacts of the influx of visitors on the County's roads, facilities, and private property owners.

The BOCC has made several recommendations to the Marine Fisheries Commission for its consideration. Those having the majority support of both the BOCC and the Marine Fisheries Commission are summarized as follows (Monroe County BOCC, 1991b):

- (a) abolish the Two-Day Lobster Sport-Fishing Season;
- (b) restrict lobstering by SCUBA and snorkel to daylight hours only;
- (c) require 100 yard buffer zones for SCUBA and snorkel adjacent to canals and residential subdivisions;
- (d) use lobster tags to mark legal catches;
- (e) back up opening day for the recreational season to coincide with the commercial season;
- (f) enhance education through bilingual pamphlets using TDC funds;
- (g) increase the cost of lobster stamps while allocating the entire increase to enforcement and education in Monroe County; and
- (h) reduce the bag limit to 6 lobsters per person or 24 lobsters per boat, whichever is less.

E. Comprehensive Fisheries Management and Habitat Preservation through the Florida Keys National Marine Sanctuary Management Plan

The Florida Keys National Marine Sanctuary Management Plan will provide the basis for future coordinated management of fisheries in the Florida Keys. Specifically the plan will provide the basis for comprehensive and coordinated fisheries management and fishery habitat preservation and restoration. The issues presented above will be specifically addressed in the recommended management strategies of the FKNMS Management Plan. Also included will be a research program designed to address the three priority research needs related to fisheries in the Keys (U.S.D.C., NOAA and RSMAS, 1991): fisheries (characterization of and understanding of fisheries); basic biology (identification and definition of critical locations, habitats, and times of critical population "bottlenecks" for important species); and, ecology (effects of fishing on community and trophic structure and energy flow).

The FKNMS Management Plan will be implemented through a series of memoranda of agreement among the various federal, state and county agencies involved in activities related to fisheries management and habitat preservation. These agreements will be executed upon completion of the Management Plan, anticipated in July/August 1993.

3.15 Air Quality

3.15.1 Ambient Air Quality Standards and Statewide Air Quality Monitoring Programs

The U.S. Environmental Protection Agency (EPA) and the Florida Department of Environmental Regulation (Florida DER) have implemented an air quality monitoring program throughout the State which measures concentrations of major pollutants in the ambient air. This program is designed to provide data regarding compliance with the legal limitations on concentrations of major pollutants in the ambient air established by both EPA and DER. Ambient air is defined as that portion of the atmosphere near ground level and external to buildings or other structures.

The six major pollutants for which limits on air quality standards, have been set are: carbon monoxide (CO), lead (Pb), nitrogen dioxide (NO₂), ozone (O₃), particulate matter (PM), and sulfur dioxide (SO₂) (see Table 3.18). Two types of national ambient air quality standards (NAAQS) have been established by the EPA for each pollutant. Primary ambient air quality standards are designed to protect public health with an adequate margin of safety (Florida DER, 1987a). Secondary standards are designed to protect public welfare-related values including property, materials and plant and animal life (Florida DER, 1987a). In Florida, ambient air quality standards at least as stringent as the national secondary standards have been adopted by the DER (see Table 3.18).

All areas within the State of Florida are designated with respect to each of the six pollutants as "attainment, unclassifiable, or nonattainment." The purpose of the nonattainment designation is to identify air quality problem areas for which the State and the EPA must seek solutions (Florida DER, 1987a). Attainment areas are those within which air quality standards are being met. Where insufficient data are available to reasonably be classified as either attainment or nonattainment the area is designated as "unclassifiable".

The DER maintains two types of ambient air quality monitoring stations throughout the State, each of which is designed to meet different objectives. The State/Local Air Monitoring Station (SLAMS) and National Air Monitoring (NAMS) network is typically established in high population areas and/or where there are significant pollutant emission sources or source categories. Data from this network provide an overall view of the state's air quality and are used in the development of statewide control strategies (Florida DER, 1987a). The Special Purpose Monitoring Network (SPM) is designed to supplement the SLAMS/NAMS network in data sparse areas. Data from these stations are used to develop and refine local control strategies and to verify maintenance of ambient standards in areas outside of the SLAMS/NAMS network (Florida DER, 1987a).

3.5.2 Monroe County Ambient Air Quality

Air quality in the Florida Keys is generally excellent. Sea breezes, coupled with the lower intensity of development and small number of point sources, result in relatively low pollutant loads which are dispersed by winds. Based upon ambient air quality monitoring, the DER has designated Monroe County as an attainment area for all six major air contaminants. This indicates that the concentrations of major pollutants in the ambient air within the Keys fall within the acceptable limits set by both DER and the U.S. Environmental Protection Agency.

The state currently maintains two SPM stations in the Keys, one at the Galleon Resort (Front Street in Key West) and the other at the DER Office in Marathon (11400 Overseas Highway). The monitor at the Marathon station commenced operations in 1991. Prior to 1991 the second Keys monitor was located at the Gerald Adams Elementary School on Stock Island. This station was shutdown when activities at the Key West Landfill were reduced.

The two stations are monitored on a 6-day cycle for total suspended particulates (TSP). In 1987, the Florida ambient air quality standards for particulate matter were revised and made applicable to inhalable particles only (particles 10 microns or less in diameter), referred to as the PM10 standard. PM10 monitors have not yet been installed in the Keys. Until such time as the equipment is available and/or the recorded TSP concentrations exceed the PM10 standard, DER will continue to collect TSP data at the two Keys stations.

Data from the two SPM stations, recorded from 1985 through 1990 indicate that particulate matter (TSP) concentrations have remained well below the state's standards (see Table 3.19). This conclusion is based on the assumption that inhalable particles typically represent 20 to 80 percent of TSP. Accordingly, if TSP concentrations remain below the PM10 standard, then the particulate matter (PM10) standard is also met.

Only one TSP exceedence has been recorded in the Keys. This occurrence, in July of 1984, was interpreted to be the result of an unusual natural dust storm and was considered as an excludable exceedence (Florida DER, unpublished data).

3.5.3 Known Sources of Air Pollution in Monroe County

Potential sources of air pollution in Monroe County generally include vehicle emissions, naturally occurring seasalt, airborne dust from disturbed areas and limestone mining operations, controlled

Table 3.18

State and Federal Ambient Air Quality Standards

Pollutant	Averaging Time	Florida Standard	Primary NAAQS	Secondary NAAQS
Carbon Monoxide	8 hour (1)	9 ppm	9 ppm	--
	1 hour (1)	35 ppm	35 ppm	--
Lead (2)	Quarterly (3)	1.5	1.5	1.5
Nitrogen Dioxide (2)	Annual (3)	100	100	100
Ozone (2)	1 hour (4)	0.12	0.12	0.12
Particulate Matter (2) (PM10)	Annual (5)	50	50	--
	24 hour (1)	150	150	--
Sulfur Dioxide (2)	Annual (2)	60	80	--
	24 hour (1)	260	365	--
	3 hour (1)	1,300	--	1,300

(1) Not to be exceeded more than once per year.

(2) Lead, nitrogen dioxide, ozone, particulate matter, and sulfur dioxide pollutant concentrations are in micrograms/cubic meter.

(3) Arithmetic mean.

(4) Not to be exceeded on more than an average of one day per year over a three-year period.

(5) Geometric mean.

Source: Florida DER, Division of Air Resources Management, 1987b.
Environmental Reporter Federal Regulations, Vol. 2.

Table 3.19

**Summary of Particulate Matter Data from
Monroe County Special Purpose Monitoring (SPM) Stations**

SPM Location	Year	24 Hour High		Annual Geometric Mean	
		TSP Concentration (1)	Florida Standard (2)	TSP Concentration (1)	Florida Standard (2)
Galleon Resort	1985	99	150 (TSP)	--	60 (TSP)
	1986	97	150 (TSP)	35	60 (TSP)
	1987	131	150 (TSP)	41	60 (TSP)
	1988	121	150 (PM10)	33	50 (PM10)
	1989	67	150 (PM10)	35	50 (PM10)
	1990	62	150 (PM10)	33	50 (PM10)
Gerald Adams Elementary School	1985	99	150 (TSP)	32	60 (TSP)
	1986	92	150 (TSP)	31	60 (TSP)
	1987	115	150 (TSP)	31	60 (TSP)
	1988	83	150 (PM10)	30	50 (PM10)
	1989	62	150 (PM10)	32	50 (PM10)
	1990	95	150 (PM10)	32	50 (PM10)

(1) Particulate matter concentrations are in micrograms/cubic meter.

(2) In 1987, the Florida ambient air quality standards for particulate matter were revised and made applicable to inhalable particles only (particles 10 microns or less in diameter). Consequently, standards shown in this table for 1985, 1986 and 1987 are TSP standards and those shown for 1988, 1989 and 1990 are PM10 standards.

Recorded concentrations shown for all years (1985 through 1990) are TSP concentrations. Generally, PM10 concentrations range from 20 to 80 percent of TSP, with an average of 50 percent.

Sources: Florida DER, Division of Air Resources Management, 1990a.

Florida DER, Division of Air Resources Management, 1989a.

Florida DER, Division of Air Resources Management, 1988a.

Florida DER, Division of Air Resources Management, 1987a.

open burning, and point sources (permitted under Chapter 17-2 and Chapter 17-4, Florida Administrative Code).

Sources of air pollutants with active DER Air Operation Permits are listed in Table 3.20. These include diesel, steam and gas turbine generators; incinerators for biological materials, sludge, and municipal solid waste; concrete batch plants; and one asphalt plant. All discharges are currently in compliance with discharge limits (James Greenshields, personal communication, 1992).

In recent years, the municipal waste combusters at the Monroe County Landfills have been the only permitted point source discharges having a series of violations (James Greenshields, personal communication, 1992). These facilities have been shut-down in conjunction with the closure of the county landfills.

3.15.4 Potential for Conservation, Use or Protection of Air Quality in Monroe County

Ambient air quality in the Keys is likely to remain excellent, due to the low intensity of development, sea breezes and limited number of point sources of pollutants. However, actions can be taken by local government to reduce the potential for localized concentrations of pollutants, particularly particulates; to support DER in regulation of point sources; and to support initiatives for statewide programs to reduce vehicle emissions.

Particulates escaping from disturbed areas in the form of fugitive dust can be controlled by on-site dust control measures. Areas exposed during construction can be treated with mulch, spray, grass or other appropriate methods in order to control dust. Use of these measures can be required as a condition of Development Orders.

Mining activities should be undertaken using dust control measures, such as continuous wetting down of excavation and handling. DER currently has regulations requiring utilization of such measures. Monroe County can require demonstration of compliance with these measures as a condition of the annual Resource Extraction Operating Permit, required by the Land Development Regulations for all active mining sites.

Open burning will continue to be regulated under Chapter 17-256, Florida Administrative Code. Accordingly, open burning is prohibited except for clean dry lumber and for debris from initial land clearing activities. Permits for open burning are issued by the Florida Division of Forestry, pursuant to Chapter 590, Florida Administrative Code.

The State of Florida is currently considering adoption of a mandatory program for the inspection and maintenance of automobile emission control systems. Adoption of this program statewide would promote proper functioning of emission control systems, thus reducing emissions from vehicles. These regulations would be enforced by state and local law enforcement officials.

State government programs are also under consideration for regulation of petroleum and gasoline storage facilities. Adoption of these programs statewide would reduce VOC emissions.

Point sources of pollution from generators, incinerators, concrete plants, and other pollutant sources which may locate in Monroe County, will continue to be regulated under Chapter 17-2 and Chapter

Table 3.20

**Sources of Air Pollutants with Active Air Operation Permits from Florida DER
(Unincorporated Monroe County)**

Source Description	Status (1)	Pollutants
Brewer Company of Florida, US 1 (mile marker 8.5)		
Asphalt Plant	A	VE
Catalyst Waste to Energy of Key West, Jr College Road, Key West		
Incinerator #1 (resource recovery, municipal solid waste)	A	VE/PM
Incinerator #2 (resource recovery, municipal solid waste)	A	VE/PM
City Electric System, Big Key Pine		
Diesel Generator	I	VE
City Electric System, Cudjoe Key		
Diesel Electric Generator	A	VE/SO2
Diesel Operating Unit	A	VE/SO2
City of Key West		
Sludge Incinerator	A	VE/PM/HG
De Poo Memorial Hospital, Key West		
Incinerator (for type 0 thru type 4 waste)	A	VE
Dean-Lopez Funeral Home, Key West		
Pathological Incinerator	A	VE
Florida keys Electric Cooperative, Tavernier		
Diesel Generator #1	A	VE
Diesel Generator #2	A	VE
Diesel Generator #3	A	VE
Diesel Generator #4	A	VE
Diesel Generator #5	A	VE
Diesel Generator #6	A	VE
Diesel Generator #7	A	VE
Florida Rock & Sand Company		
Concrete Batch Plant	A	VE
Key West Utility Board, Stock Island		
Diesel Engine #1	C	VE
Diesel Engine #2	C	VE
Diesel Peaking Unit #1	A	VE
Diesel Peaking Unit #2	A	VE
Diesel Peaking Unit #3	A	VE
Steam Turbine Electric Generator	A	VE/SO2/PM
Diesel Engine #1	C	VOC/PM/SO2/BE/CO/NOX
Diesel Engine #2	C	VOC/PM/SO2/BE/CO/NOX
Key West Utility Board, Trumbo Road		
Gas Yurbine Electric Generator	A	VE/SO2
Unit # 3	I	SO2
Unit #4	I	SO2
Unit #5	I	SO2
Marathon Animal Shelter, Marathon		
Pet Incinerator	A	VE
Memorial Gardens Crematory, Marathon		
Crematory Retort with Afterburner	C	VE

Table 3.20 (continued)

**Sources of Air Pollutants with Active Air Operation Permits from Florida DER
(Unincorporated Monroe County)**

Source Description Description	Status (1)	Pollutants
Monroe County Municipal Services District, US 1 (mile marker 21) Air Curtain Incinerator	A	VE
Monroe County Municipal Services District, US 1 (mile marker 67) Air Curtain Incinerator	C	VE
Monroe County Municipal Services District, State Road 905 Air Curtain Incinerator	A	VE
Pinewood Materials Corporation, US 1 (mile marker 9) Concrete Batch Plant	A	VE
Pinewood Materials Corporation, US 1 (mile marker 30) Concrete Batch Plant	A	VE
Tarmac Florida, Inc., (US mile marker 31.5) Concrete Batch Plant	A	VE
Tarmac Florida, Inc., (US mile marker 9) Concrete Batch Plant	A	VE
U.S. Department of Agriculture, Harry S. Truman Animal Import Center Incinerator #1 (pathological)	A	VE
Incinerator #2 (pathological)	A	VE
Incinerator #3 (pathological)	A	VE

(1) A-Active

C-Construction

I-Inactive

(2) VE-Visible Emissions

VOC-Volatile organic compounds

PM-particulate matter

SO₂-sulfur dioxide

BE-beryllium

CO-carbon monoxide

NO_x-nitrogen dioxide

HG-Mercury

Source: Florida DER, Division of Air Resources Management (Marathon Office), October 25, 1991.

17-4, Florida Administrative Code. This permitting program is designed to ensure that point source emissions are in compliance with state and federal air quality standards.

3.16 Water Needs and Use

3.16.1 Current (1992) Water Needs and Sources

The current (1992) demand for potable water by existing and committed residential and non-residential uses in the Florida Keys as of April 1, 1990 is estimated at approximately 8.83 million gallons per day. (See Potable Water Chapter Section 8.10.)

The primary source of potable water consumed in the Keys is the Biscayne Aquifer in southeastern Dade County. Water is pumped from the Florida City Wellfield and distributed by the Florida Keys Aqueduct Authority (FKAA). With treatment, water drawn from the Biscayne Aquifer meets all federal and state drinking water standards. Alternative potable and non-potable water supplies in use include private cisterns, private wells, home desalinization systems and bottled water. Most users of these alternative sources rely on them only as supplements to the FKAA water. Cistern and well water is typically reserved for irrigation and other non-potable uses. (See Potable Water Chapter Section 8.10.)

Potable water is supplied to the Keys by the FKAA according to the terms of the current consumptive use permit (SFWMD Water Use Permit No. 13-00005-W). A complex set of interagency and intergovernmental agreements control the water allocation and distribution. Agencies and governments which are parties to these agreements include FKAA, the South Florida Water Management District (SFWMD), the Department of Environmental Regulation (Florida DER), Monroe County, and the City of Key West. (See Potable Water Chapter Section 8.2.)

3.16.2 Projected Ten-Year (2002) Water Needs and Sources

The ten-year projected demand (2002) for potable water from residential and non-residential uses in the unincorporated areas of the Keys is estimated at 8.05 million gallons per day. This water will continue to be provided by the FKAA. Upon adoption of the Monroe County Comprehensive Plan, the SFWMD Consumptive Use Permit will be revised to provide for this projected demand. Water will continue to be obtained from the Florida City Wellfield. (See Potable Water Chapter Sections 8.9 and 8.10.)

3.16.3 Water Conservation Strategies

Water conservation strategies in use or under consideration in the Keys focus upon leak detection and repair; metering to detect unaccounted-for water; reuse of wastewater; and reduction of consumption through a conservation-oriented rate structure, distribution of water conservation kits, adoption of a Xeriscape Landscape Ordinance, adoption of plumbing fixture efficiency standards, and reuse of wastewater.

The ten-year (2002) water need projection accounts for the FKAA Leak Detection Program, which has a goal of 13 percent unaccounted for water. (See Potable Water Chapter Section 8.8.1.)

3.17 Hazardous Wastes and Hazardous Materials

3.17.1 Solid Waste Disposal Sites

Inactive Monroe County Landfills and abandoned landfill sites are addressed above in Section 3.5.3 B. The discussion includes:

- a) identification of inactive Monroe County landfills and abandoned dumps in unincorporated Monroe County; and
- b) general discussion of the potential water quality impacts related to landfill leachate contamination of nearshore waters.

3.17.2 Hazardous Waste Disposal Sites

The U.S. Environmental Protection Agency's Comprehensive Environmental Response, Compensation and Liability Information System (CERCLIS) include five known, alleged or potential hazardous waste sites in the Florida Keys, including the City of Key West. These are as follows:

Key West Gasification, Key West;
Marathon Key Abandoned Drum, Marathon Key;
Trans Current Inc.;
U.S. Naval Air Station Boca Chica; and
U.S. Coast Guard Station, Key West.

Ten contaminated sites have been documented at the U.S. Naval Air Station at Key West (Florida DER, Lisa Gordon, personal communication). Plans are being developed for cleaning up the contamination.

DER has identified one additional contaminated site (Florida DER, 1989b) not found on the CERCLIS list. This site, owned by Coastal Exterminating Service, exhibited documented soil contamination from pesticides. Cleanup activities were undertaken pursuant to a 1983 consent judgment. Soil samples taken in 1991 continued to show evidence of pesticide contamination (Florida DER, Lisa Gordon, personal communication).

3.17.3 Hazardous Waste Generators

Forty-four hazardous waste generator sites are currently registered in the Florida Keys (CSA, 1991). Data quantifying the type of hazardous materials generated at these sites are not available. All but one of these sites are small quantity generators. The only large quantity generator in the County is comprised of the combined waste generating facilities at the Key West Naval Air Station (Boca Chica, Truman Annex and Trumbo Point) (Florida DER, Lisa Gordon, personal communication).

3.17.4 Household Hazardous Wastes

Improper handling and disposal of many common household products in trash and septic systems pose threats of ground and surface water contamination, exposure of homeowners to health risks, potential injuries to sanitation workers, and possible damage to packaged treatment plants. The list of household products that are considered hazardous includes a range of household cleaners, automotive products, home maintenance and improvement products, and lawn and garden products used everyday in the home. Many users remain unaware of the hazards associated with the use of these substances despite public education efforts.

Because of the threats of household hazardous waste to drinking water supplies, the Florida Legislature in 1983 authorized DER to implement the Amnesty Day Program in which the public, schools, small businesses and farmers could have small quantities of these wastes disposed of properly at no charge. This program is implemented in Monroe County by the Department of Environmental Management (DEM).

DEM currently maintains two facilities for temporary storage of small quantities of household hazardous waste. The County has periodic "Amnesty Days", when small quantities can be dropped off by county residents, free-of-charge. At present the waste collected at these facilities is transported out of the County for disposal. (See Solid Waste Chapter Section 9.4.4.)

3.17.5 Underground and Aboveground Storage Tanks

Most underground storage tank installations in the Florida Keys are costly, difficult and require floating and ballasting of tanks to anchor them into position (FIMC, 1991). This is due to the high water table, shallow soils, and presence of coral rock typically lying within one to ten feet of the ground surface. Because of these conditions, many storage tank owners prefer aboveground storage tanks to underground storage tanks (FIMC, 1991).

DER regulates underground and aboveground storage tanks according to the following rules:

- (a) Chapter 17-761, F.A.C. regulates all underground storage tanks over 110 gallons containing pollutants and CERCLA Hazardous substances; and
- (b) Chapter 17-762, F.A.C. regulates all aboveground tanks over 550 gallons containing pollutants.

Both rules require secondary containment for new tanks and have a schedule for upgrading existing tanks with secondary containment.

Pursuant to the SUPER Act of 1986, DER has entered into a contract (effective December 1, 1990) with the Monroe County HRS Unit to perform annual compliance inspections of storage tank facilities in Monroe County. Included in the contract are installation and removal inspections, as well as enforcement activities.

As of May 1, 1991, the Monroe County HRS Unit identified 467 storage tanks in Monroe County (FIMC, 1991). This number is estimated to include approximately 99 percent of the tanks in the

County. As of the same time, the Monroe County HRS Unit had performed the following inspection activities of registered tanks (FIMC, 1991):

- 87 inspections of existing facilities;
- 1 inspection of a facility installation;
- 1 inspection of a facility closure/removal; and
- 46 enforcement actions on existing facilities.

As of the same time, the following cleanup-related activities had occurred (FIMC, 1991):

- 64 reported discharges;
- 58 facilities participating in DER-funded cleanup programs; and
- 8 facilities under DER enforcement actions.

A discharge is reported when a suspected underground storage tank leak has contaminated the surrounding soils, surface waters immediately adjacent to the tank, or groundwaters directly beneath a tank.

Financial assistance is available from the State is available to clean up eligible sites with contamination from petroleum storage tank systems. In Monroe County eligible sites include 51 facilities participating in the Early Detection Incentive Program and 35 facilities with coverage under the Florida Petroleum Liability Insurance and Restoration Program (FLIRP)(FIMC, 1991). Facilities without Financial Responsibility Coverage are liable for all third party damage claims as well as restoration costs. DER has cited a need to encourage owners of storage tank facilities in the Keys to comply with state and federal financial responsibility requirements or to participate in the optional FLIRP (FIMC, 1991).

Because of water table, soil and rock conditions in the Keys, when a discharge from a storage tanks occurs, it is more likely to affect surface waters than groundwaters (FIMC, 1991).

3.17.6 Hazardous Material Spills

Hazardous Material Spills in Terrestrial Environments

Data available from DER (January 1987 to June 1991) and from the U.S. Coast Guard's National Response Center (October 1984 to March 1990) indicate a total of 93 reported spills in the Florida Keys (CSA, 1991). At least 26 of these spills occurred in the City of Key West (CSA, 1991).

The most frequently spilled hazardous materials have been petroleum products (CSA, 1991). Other spilled substances included chemicals, raw sewage, miscellaneous toxic substances, and unclassified substances (such as soot and ash, foam, garbage, etc.)(CSA, 1991). Structural failure and natural seepage from storage facilities were responsible for the largest percentage of the hazardous material spills (CSA, 1991). Equipment failure and human error accounted for the remaining classified spills reported (CSA, 1991).

DER regulatory and inspection programs for storage tank facilities (Chapters 17-761 and 17-762, F.A.C.), implemented by the Monroe County HRS Unit, are designed to prevent spills from storage facilities due to leakage, overfilling, and structural failures (see Section E above). It is anticipated

that these programs will sharply reduce the number of spills from storage facilities in the future, particularly as older facilities are inspected and replaced.

Currently the Emergency Response Section of DER does not have personnel located in Monroe County. There are plans to establish an emergency response team within DER's Marathon Office staff.

Hazardous Material Spills in Marine Environments

There were 355 reported spills of hazardous materials in the waters of the Florida Keys National Marine Sanctuary in the period between October 1985 and August 1991 (CSA, 1991). Approximately 44 percent of the spills occurred on the Atlantic Coast within 3 nmi from shore; approximately 37 percent occurred on the Gulf Coast within the same distance of the shore; and the remaining spills were dispersed among nearshore waters (canals and harbors) and Atlantic and Gulf contiguous and offshore waters (more than 3 nmi offshore) (CSA, 1991).

Petroleum products, primarily gas and diesel fuel, were the most commonly spilled substances, with an average discharge per incident of 30.05 gallons (CSA, 1991). Based upon historic spill rates, it is estimated that approximately 1,598 gallons of oil-related products have been released annually over the last six years (CSA, 1991).

Given historical spill volumes, marine spills do not represent a significant threat to marine waters in the Keys. The marine communities and habitats of the Keys are relatively resistant to minor amounts of oil floating on the water surface (CSA, 1991). However, a catastrophic spill resulting from a major tanker grounding or any other major shipping accident, could have serious environmental consequences. This risk has been reduced, although not eliminated, by recent federal regulations which have moved tanker traffic further offshore (CSA, 1991).

3.18 Areas of Particular Concern, Conservation Lands and Units of the Coastal Barrier Resources System

3.18.1 Areas of Particular Concern

Areas of particular concern with respect to the natural environment have been well documented in past planning studies undertaken by Monroe County. The in-depth analysis of biological communities in the Keys conducted during preparation of the 1986 "Florida Keys' Comprehensive Plan" (Monroe County Dept. of Planning, 1986a and 1986b) identified these areas and proposed revised resource management policies and land development regulations designed to better protect natural resources.

A review of these areas undertaken by County Staff in 1990 while preparing the "Monroe County Comprehensive Plan 1990-2010" (Monroe County Department of Planning, 1991), confirmed the identification of areas of particular concern and proposed refinements to the land development regulations designed to provide further protection to natural resources.

Natural areas of particular concern in the Florida Keys fall into four broad categories (Monroe County Department of Planning, 1986b):

- (a) Marine Resource Areas;
- (b) Natural Vegetation Resource Areas;
- (c) Natural Landform and Feature Resource Areas; and
- (d) Terrestrial Wildlife Resource Areas.

Table 3.21 lists the specific resource areas present in the Keys assigned to each of these four broad categories. Except for resource areas marked with an asterisk, this list is taken from the 1986 "Florida Keys' Comprehensive Plan".

Resource areas listed in Table 3.21 and marked with an asterisk are recommended additions to the areas of particular concern identified in the 1986 Plan. These include the following:

- (a) addition of aquatic preserves, wildlife refuges, CARL project sites, and units of the Coastal Barriers Resources System, many of which were established since the 1986 Plan was completed;
- (b) addition of undisturbed salt marsh and buttonwood wetlands (to reflect recent policy directives of the Board of County Commissioners); and
- (c) addition of open water (primarily including salt ponds and freshwater ponds)(to reflect the 100 percent open space requirement adopted in the current "Monroe County Land Development Regulations (LDR's)" (Monroe County BOCC, 1990)).

Each of the "generic designations" for the areas of particular concern listed in Table 3.21 are addressed in relevant preceding sections of the Conservation and Coastal Chapter. These discussions address the following subjects for each of the generic designations:

- (a) Existing Commercial, Recreational and Conservation Uses;
- (b) Known Pollution Problems and/or Issues; and
- (c) Potential for Conservation, Use of Protection.

Site specific designations of areas of particular concern fall into two categories:

- (a) publicly-owned conservation lands; and
- (b) units of the Coastal Barrier Resources System.

These are discussed below, including a brief discussion of land area, conservation purpose, and existing management problems.

Table 3.21

Natural Areas of Particular Concern in Monroe County

Marine Resource Areas	
Criteria for Designating Areas of Particular Concern:	
1.	areas of unique, scarce, fragile, or vulnerable natural habitat, physical feature and scenic importance;
2.	areas of high natural productivity or essential habitat, for living resources, including fish, wildlife, and the various trophic levels in the food web critical to their well-being;
3.	areas of substantial recreational value and/or opportunity; and
4.	area needed to protect, maintain or replenish coastal lands or resources, including coastal floodplains, coral and other reefs, beaches, offshore sand deposits and mangrove stands.
Site Specific Designations	
1.	Lignumvitae Key Aquatic Preserve;
2.	Coupon Bight Aquatic Reserve
3.	John Pennkamp Coral Reef State Park;
4.	Florida Keys National Marine Sanctuary
5.	Key Largo Coral Reef Marine Sanctuary;
6.	Looe Key National Marine Sanctuary
7.	Biscayne Bay/Card Sound Aquatic Preserve:*
8.	Card Sound Lobster Sanctuary*
9.	Florida Keys Units of the Coastal Barriers Resources System:*
a.	all of north Key Largo that is undeveloped and not in public ownership;
b.	offshore keys of Rodriguez and Dove
c.	Tavernier Key, also the area on both sides of US 1 between Point Lowe and Tavernier Creek;
d.	south end of Plantation Key between Treasure Harbor and Snake Creek and South of US 1;
e.	Channel Key;
f.	Toms Harbor Key;
g.	Little Crawl and Deer Keys, the southern two-thirds of Long Point Key and the undeveloped portion of Fat Deer Key;
h.	Boot Key;
i.	the undeveloped part of No Name Key that is not in public ownership;
j.	Newfound Harbor Keys;
k.	Little Knockemdown, Howell, Pye, Crab, Money, Gopher and the undeveloped, unprotected part of Big Torch Keys;
l.	Budd Keys;
m.	Sugarloaf Key, south of U.S. 1 and east of S.R.939;
n.	Halfmoon, O'Hara, Saddlehill, Bird, and Pelican Keys; and
o.	Cow Key;
Generic Designations:	
1.	all marine grass beds in waters off the Florida Keys;
2.	all patch reef coral and other reef formations found in the surrounding waters off the Keys; and
3.	all mangroves and associated vegetation extending up to 50 feet laterally upland from the landward limit of the shoreline mangrove;
4.	all undisturbed salt marsh and buttonwood wetlands;*
5.	areas of open water with no discernable emergent vegetation, primarily including salt ponds and freshwater wetlands.*

Table 3.21 (cont'd)

Natural Areas of Particular Concern in Monroe County

Natural Vegetation Resource Areas	
Criteria for Designating Areas of Particular Concern:	
1.	areas containing plant communities of unique character and/or threatened or endangered species;
2.	vegetative communities exceptionally outstanding in growth and structure;
3.	isolated communities of well developed natural vegetation in urban or rapidly urbanizing areas; and
4.	areas of substantial recreational and/or educational value and/or opportunity.
Site Specific Designations:	
1.	cactus hammock on Big Pine Key;
2.	Key Largo State Botanical Site;*
3.	Curry Hammock CARL Project Site;* and
4.	Lignumvitae Key State Botanical Site*.
Generic Designations:	
1.	high quality high hammock;
2.	high quality low hammock
3.	high quality pineland; and
4.	cactus hammock
Natural Landform and Feature Resource Areas	
Criteria for Designating Areas of Particular Concern:	
1.	a geologic, hydrologic or physiographic feature confined to a small area of the Keys and considered quite rare locally or regionally;
2.	a representative natural ecosystem and/or its units existing in a few isolated locations but extirpated from most of the Keys; and
3.	a natural landform or feature considered quite unique and having substantial educational and/or scientific value.
Site Specific Designations:	
1	Windley Key State Geological Site*.
Generic Designations:	
1.	freshwater aquifers;
2.	freshwater marshes and ponds; and
3.	sandy beaches and young dunes.
Terrestrial Wildlife Resource Areas	
Criteria for Designating Areas of Particular Concern:	
1.	existing wildlife refuges, reserves, and sanctuaries;
2.	known habitats of rare and endangered species as defined by the U.S. Department of Interior, the Florida Game and Freshwater Fish Commission, or the Florida Department of Natural Resources;
3.	major wildlife intensive use areas such as well developed hammock communities, highly productive coastal tidelands, and mangroves;
4.	areas used for scientific study and research concerning wildlife; and
5.	areas of substantial recreational and/or educational value and/or opportunity.
Site Specific Designations:	
1.	National Key Deer Refuge;
2.	Great White Heron National Wildlife Refuge
3.	Key West National Wildlife Refuge;
4.	Crocodile Lake National Wildlife Refuge;
5.	Looe Key National Wildlife Refuge;*
6.	Key Largo National Marine Sanctuary;*
7.	Coupon Bight/Key Deer CARL Project site;*
8.	Curry Hammock CARL Project site;* and
9.	North Key Largo CARL Project site*.
Generic Designations	
1.	all prime wildlife habitat areas in hammock communities, coastal tidelands and mangroves.

* Resource areas which are proposed to be added to those listed in the 1986 "Florida Keys' Comprehensive Plan"

Source: Monroe County Department of Planning, 1986b.

3.18.2 Conservation Lands

Many of the most significant marine and terrestrial biological communities found in the Florida Keys have been protected through acquisition by the federal and state governments. Within the uplands and marine waters of the Florida Keys there are four national wildlife refuges, three national marine sanctuaries, three aquatic preserves, two state botanical sites, one state geological site, one state park, two state recreation areas, and three CARL projects.

A. Federally-Owned Conservation Lands

There are approximately 1.2 million acres of lands or waters under federal jurisdiction in Monroe County (Table 3.22). These are mainly large, resource-based conservation areas that include environmentally significant marine, wetland and/or upland habitats. These areas function to protect and preserve resources and habitats and provide passive and active recreation and environmental education opportunities for residents of and visitors to the region. Federally-owned conservation lands in Monroe County are described below.

Everglades National Park

Everglades National Park encompasses approximately one million acres in southern Florida, including the entire Mainland portion of Monroe County. The Park's borders extend into Florida Bay to include all of the submerged land and offshore island lying north of the Intracoastal Waterway between Cross Key to the east and approximately Long Key to the west.

Big Cypress National Preserve

Big Cypress National Preserve is located on the Mainland, includes portions of Monroe, Collier, and Dade Counties, and borders Everglades National Park to the north. The Preserve was established in 1974 for the purpose of ensuring the "preservation, conservation and protection of the natural, scenic, hydrologic, floral and faunal, and recreation values of the Big Cypress Watershed" and to "provide for the enhancement and public enjoyment thereof" (U.S. Department of the Interior, National Park Service, 1989).

Fort Jefferson National Monument

The Dry Tortugas lie approximately 70 miles to the west of Key West, and represent the last outer islands of the Florida Keys. The Dry Tortugas were discovered by Ponce de Leon in 1513 and were used by pirates as refuge until 1821, when Florida became part of the Union. After the islands gained strategic significance, the US Army started construction of Fort Jefferson. The fort was later used as a prison during the Civil War. Given its importance in American history, the islands and their surrounding waters were designated as Fort Jefferson National Monument in 1935 and are managed by the National Park Service.

Crocodile Lake National Wildlife Refuge

The Crocodile Lake National Wildlife Refuge was established in 1978 and includes 7,100 acres of shoreland mangroves and tropical hardwood hammocks on North Key Largo. The Refuge includes a number of endangered and threatened species, including the American crocodile (Crocodylus acutus), the Florida manatee (Tricheus manatus latirostris), the Schaus' swallowtail butterfly (Papilio aristodemus ponceanus), the Key Largo wood rat (Neotoma floridana smalli), the Key Largo cotton

mouse (Peromyscus gossypinus allapaticola), and the Eastern indigo snake (Drymarchon corais couperi).

The decline in the south Florida population of the endangered American crocodile has been attributed to two levels of human activities: (1) habitat alterations, and (2) direct human disturbance to crocodiles and their nests. The Refuge was established to prevent both habitat destruction and human intrusion into an area that is essential to maintaining a self-sustaining crocodile population in the United States.

Great White Heron National Wildlife Refuge

The Great White Heron National Wildlife Refuge was established in 1938 in order to protect the nursery and nesting grounds of the Great white heron (Ardea herodias oxydentalis). The Refuge encompasses approximately 320 square miles in the Lower Keys, with approximately 7,400 acres currently in public ownership, including most of the offshore islands in the Lower Keys. Management problems associated with these relatively remote islands include propeller scouring of seagrass beds; disturbance of migratory and wading waterfowl habitat and nesting sites and of turtle nests; and destruction of habitat and disposal of garbage by visitors to these islands.

National Key Deer Refuge

The National Key Deer Refuge was established in 1954 in order to protect the Key deer (Odocoileus virginianus clavium) and its habitat. The Refuge includes Big Pine Key and several other Keys and offshore islands, including portions of No Name, Sugarloaf, Cudjoe, Ramrod and the Torch Keys. The Refuge has an active acquisition program to acquire core habitat areas primarily on No Name Key and northern and central Big Pine Key in addition to Key deer movement corridors on Big Pine Key. The Fish and Wildlife Service has acquired approximately 8,100 acres to date. The reduction and fragmentation of Key deer habitat, road kills, increased human/deer interaction, and the Key deer's innately low reproductive rate have resulted in an observed decline in the Key deer population and are preventing a recovery (Garrett and Robertson, 1989).

Key West National Wildlife Refuge

The Key West National Wildlife Refuge was the first refuge designated in Monroe County in 1908. It includes approximately 2,019 acres of submerged lands and small islands lying west of Key West and extending to the Marquesas, a grouping of offshore islands southwest of Key West. All of the offshore islands within the Refuge between Key West and the Marquesas are in public ownership, with the exception of Ballast Key.

Looe Key National Marine Sanctuary

The Looe Key National Marine Sanctuary was established in 1981 to protect the fragile coral reef which surrounds Looe Key, which is located approximately 6 miles to the south of Big Pine Key. The Sanctuary encourages both commercial and recreational uses as long as those activities are not in conflict with the health or overall enhancement of the resources of the area.

Key Largo National Marine Sanctuary

The Key Largo National Marine Sanctuary was established in 1975 in order to protect the Key Largo coral reef system. The sanctuary includes approximately 100 square miles off the southeastern coast of Key Largo. The sanctuary includes a mooring buoy system to provide a convenient means of securing a boat without dropping anchor on the fragile coral formations.

B. State-Owned Conservation Lands and Facilities

The state of Florida owns approximately 81,000 acres of lands and waters in Monroe County and the surrounding waters of the Atlantic and Florida Bay (Table 3.23). State-administered facilities include large areas of significant marine or terrestrial habitats. These facilities often contain resource-based recreational opportunities such as camping, fishing or boating. The state also maintains smaller recreational sites throughout the Keys. Most of these sites promote water-related recreation and contain facilities such as beaches, boat ramps, docks, and picnic facilities. State-owned conservation and recreation lands in Monroe County are described below:

John Pennekamp Coral Reef State Park

The John Pennekamp Coral Reef State Park includes approximately 2,290 acres of upland and 53,722 acres of submerged lands on North Key Largo. The Park is managed primarily to preserve and maintain a natural setting of exceptional quality, while at the same time permitting a full program of compatible passive and active recreational activities. The Park includes several RV/trailer sites, swimming beaches, picnic areas, dive boat operations and other concessions.

Long Key State Recreation Area

Long Key State Recreation Area includes approximately 850 acres of uplands and 115 acres of submerged on Long Key in the Middle Keys. The Area is managed to meet the more active recreation needs of the public, although certain areas of exceptional natural value have been set aside for special protective management. The Area includes RV/trailer sites, camp sites, and canoe trails and rentals.

Bahia Honda State Recreation Area

Bahia Honda State Recreation Area consists of approximately 314 acres on Bahia Honda Key. The Recreation Area provides extensive recreational opportunities, including camping, picnicking, sunbathing, snorkeling, swimming, and fishing. The Area also contains significant natural resources which require special protective management, including tropical hardwood hammocks, mangroves, and sand dunes.

With regard to activities which may affect the resources of the Area, the Bahia Honda State Park Unit Management Plan (Florida DNR, 1990a) states that pollution of the marine environment is of concern:

"Turbidity caused by dredging on neighboring islands introduces the danger of siltation of grass beds and corals. Development on land, notably marinas, canals, boat docks and boat basins, is associated with chemical water pollution. Sewage, fuel, oil, grease, anti-fouling paints, pesticides, trace metals, PCBs, plasticizers, and other toxic pollutants spill, leach, or are discharged into the adjacent marine environment. These chemicals are toxic to marine life, and some are lethal at extremely low concentrations. Pollution originating at sea from pleasure boats or ships in the Gulf Stream compound the problem. Oil spills may foul the beaches and threaten marine and birdlife. Good water quality is of utmost importance for the maintenance of a healthy marine environment."

Table 3.22

Inventory of Federally-Owned Conservation Lands

Name	Location	Acres			Facilities
		Total	Upland	Submerged*	
National Park Service					
Everglades National Park	Mainland	942,702.0	NA	NA	Visitor Centers/Information Areas Main Visitor Center, Royal Palm Visitor Center, Hidden Lake Interpretive Center, Daniel Beard Center, Flamingo Visitor Center Canoe Trails Hells Bay, Bear Lake, Wilderness Waterway West Lake, Noble Hammock, 9-Mile Pond Hiking Trails Pinelands, Anhinga, Gumbo-Limbo, Pa-hay-okee Mahogany Hammock, Shark Valley Other 235 RV, Trailer Sites, 31 Primitive Camp Sites, 64 Camp Sites, 15 Cabin-Shelters, Marina, Beach, 3 boat ramps
Big Cypress National Preserve	Mainland	(1) 126,362.3	126,362.25	0.00	Hunting, Hiking Trails
Fort Jefferson National Monument	Dry Tortugas	(2) 61,519.3	39.28	61,480.00	10 Tent Sites, 10 tables, Museum, Interpretive Building, Hiking Trail, Beach
U.S. Fish and Wildlife Service					
Crocodile Lake National Wildlife Refuge	North Key Largo	(3) 5,387.0	NA	NA	Not applicable
Great White Heron National Wildlife Refuge	Big Pine to Key West	(4) 7,408.0 (5)	NA	NA	Beach
National Key Deer Refuge	Big Pine to Sugarloaf	(5) 8,091.0 (6)	NA	NA	Nature Trail, Information Center
Key West National Refuge	Key West	2,019.0	NA	NA	
National Oceanic and Atmospheric Administration					
Looe Key National Marine Sanctuary	Big Pine Key (offshore)	3,903.4	0.00	3,903.44	Historic/Archeological Structure
Key Largo National Marine Sanctuary	Key Largo (offshore)	73,649.9	0.00	73,649.88	Not applicable
Total		1,231,041.9			

* Below the mean high water line

- (1) Approximately 74.75 additional acres of privately owned lands are within the boundary of Big Cypress National Preserve
- (2) Approximately 3,220 additional acres of submerged lands owned by the State of Florida are within the boundary of Fort Jefferson National Monument
- (3) An additional 1,713 acres of privately owned lands within the boundary of Crocodile Lake National Wildlife Refuge are planned for future acquisition
- (4) The total acreage includes 1,200 acres under perpetual lease from the State of Florida since 1936
- (5) Approximately 100 acres within National Key Deer Wildlife Refuge and Great White Heron National Wildlife Refuge are submerged lands
- (6) Approximately 3,400 additional acres of privately owned lands are intended to be acquired for the National Key Deer Refuge

Table 3.23

Inventory of State-Owned Conservation Lands

Name	Location	Acres			Facilities
		Total	Upland	Submerged*	
State Parks and Recreation Areas					
John Pennekamp Coral Reef State Park (2)	Key Largo	56,010.3	2,349.6	53,660.7	47 RV/Trailer Sites, Dumping Station, 122 Tables, 21 Shelters, Beach, Boat Ramp, Marina, Visitor Center, Concessions
Long Key State Recreation Area	Long Key	966.3	849.5	116.8	30 R.V./Trailer Sites, 30 Tent Sites, 6 Shelters, Interpretive/Nature Trails, Canoe trails & rentals, Observation Tower
Bahia Honda State Recreation Area	Bahia Honda	325.1	325.1	0.0	48 R.V./Trailer Sites, 32 Tent Sites, 6 Cabins, 142 Tables, 12 Shelters, Trails, Beach, Boat Ramp, 2 Marinas
State Botanical, Geological and Historic Sites					
Key Largo Hammock State Botanical Site	N. Key Largo	1,038.8	1,038.8	0.0	Transitional, under preliminary planning
Lignumvitae Key State Botanical Site	Lignumvitae Key	586.2	485.7	100.5	Historic/Archeological Structures, Interpretative/Nature Trail, Docking Facilities
Windley Key State Geological Site	Windley Key	28.9	28.4	0.5	Transitional, under preliminary planning
Indian Key State Historic Site	Indian Key	114.8	17.0	97.8	Interpretive/Nature Trail, Docking Facilities
State Aquatic Preserves					
Lignumvitae Key State Aquatic Preserve	Lignumvitae Key	8,320.0	0.0	8,320.0	Not applicable
Biscayne Bay-Card Sound State Aquatic Preserve	Ocean Reef (offshore)	7,080.0	0.0	7,080.0	Not applicable
San Pedro Archeologic Aquatic Preserve	1 mi south of Indian Key	72.1	0.0	72.1	Historic/Archeological dive site, mooring buoys
Coupon Bight State Aquatic Preserve	Big Pine Key	6,000.0	0.0	6,000.0	Not applicable
Other State Acquisitions					
North Key Largo Hammock CARL Project	North Key Largo				1,399 acres remaining to be acquired. To be incorporated into Key Largo Hammock State Botanical Site (see above).
Port Bougainville	Key Largo	274.0	249.1	24.9	Use undecided; under preliminary planning.
North Layton Hammock CARL Project	Long Key				74 acres to be acquired. To be managed as part of the Long Key State Recreation Area.

Table 3.23

Inventory of State-Owned Conservation Lands

Name	Location	Acres			Facilities
		Total	Upland	Submerged*	
Curry Hammock CARL Project	Fat Deer/ Little Crawl Keys	365.0	365.0	0.0	Acquired in October 1991; plans for use of site to be determined
Coupon Bight/Key Deer/ CARL Project	Big Pine Key	117.0	117.0	0.0	To be incorporated into Coupon Bight Aquatic Preserve and National Key Deer Refuge.
Cowpen's Rookery Preserve	Off Plantation Key	165.0	165.0	0.0	Leased to and managed by the National Audobon Society
Save Our Rivers Program South Florida Water Management District	Big Pine Key	190.3	190.3	0.0	Currently owned managed by the SFWMD but eventually lands will be transferred to USFWS to be incorporated in National Key Deer Wildlife Refuge
Total		81,298.5	5,825.2	75,473.3	

* below the mean high water line

Source: Florida Department of Natural Resources: Div. of Recreation and Parks, Properties Under the Jurisdiction of the Division, July 1, 1991 and

Div. of State Lands, Aquatic Preserves Status Report, November 1989

National Audobon Society

Monroe County Land Authority

South Florida Water Management District

Table 3.24

Inventory of Other Conservation Lands

Name	Location	Acres(1)	Facilities	Ownership/Management
<i>Florida Keys Land and Sea Trust</i>				
Crane Point Hammock	Marathon	63	Hiking trails, two museums	Owned and managed by FKL&ST
Cudjoe Key Parcel Spoonbill Sound	Cudjoe Key	20	Hammock preserve	Perpetual conservation Easement
Ocean Reef Club Parcel Sunrise Cay Park	North Key Largo	4	Private & Preserve	Owned and managed by FKL&ST
<i>The Nature Conservancy</i>				
Lower Matecumbe	Lower Macumbe Key	26	NA	Owned and managed by TNC
Cross Keys Mangroves	North Key Largo	123	NA	Owned and managed by TNC
Big Pine Holdings	Big Pine Key	2		Will eventually be turned over to USFWS as part of National Key Deer Wildlife Refuge
Torchwood Hammock	Little Torch Key	132		Owned and managed by TNC

(1) Total acres may include some submerged lands.

Source: Monroe County Department of Planning
Florida Keys Land and Sea Trust
The Nature Conservancy
Monroe County Land Authority

Key Largo Hammock State Botanical Site and CARL Project

The Key Largo Hammock State Botanical Site includes approximately 1,800 acres on the southeast side of State Road 905 on North Key Largo. The primary purposes of the Site are the preservation of: 1) offshore marine communities found in John Pennekamp Coral Reef State Park; 2) the entire native subtropical island ecosystem on North Key Largo; and 3) habitat of several endangered species, including the Key Largo wood rat, Key Largo cotton mouse, Schaus' swallowtail butterfly, and the American crocodile.

North Key Largo hammocks is the best example of tropical hardwood hammock that remains in the United States. This rapidly disappearing natural community type supports numerous plant and animal species that have very limited distributions and are considered rare and endangered. Special environmental concerns include poaching, dumping of garbage, maintaining and restoring native vegetation, and exotic species control.

The Florida DNR continues to acquire properties through the North Key Largo CARL Project, which is currently listed as the second priority on the 1991 CARL Acquisition List. All of the land on the southeast side of State Road, with the exception of three IS subdivisions, have either been acquired or are identified for acquisition. 1,800 acres have been acquired to date with an additional 1,399 acres remaining to be acquired.

Lignumvitae Key State Botanical Site

The Lignumvitae Key State Botanical Site includes 280 acres of uplands and 100 acres of submerged lands. The primary purpose of the site is to protect a virtually undisturbed subtropical hardwood hammock. Facilities include a public dock, restrooms, visitors center/historic site, and nature trails. Access to the site is restricted, with guided tours provided four times daily five days a week (1989-90 visitation was 764 persons). Special concerns include the effects of increased population and recreational demands and the associated pollution and physical damage to the resources of Lignumvitae Key.

Shell Key State Botanical Site

Shell Key State Botanical Site is a mangrove island that provides valuable rookery habitat.

Windley Key State Geological Site

Windley Key State Geological Site includes approximately 30 acres of significant botanical, geological and historic resources on Windley Key.

Indian Key State Historic Site

Indian Key was the site of an active colony for ship salvaging operations in the mid-1820s and was the first county seat for Dade County in the 1830s. It is located one mile east of lower Matecumbe Key and is accessible only by private boat. In 1840, Seminole Indians attacked and killed seven people. The site is listed on the National Register of Historic Places and includes remnants of the original salvaging colony as well as an interpretive/nature trail and docking facilities.

Lignumvitae Key State Aquatic Preserve

The Lignumvitae Key State Aquatic Preserve encompasses approximately 7,500 acres of seagrass meadows, deep water channels and hardbottom communities that provide nursery and settlement habitat for a wide variety of marine species. The three navigable channels that traverse the preserve

from north to south are flanked on either side by broad seagrass flats that may be partially exposed during low tide. The shallow water flats are prime feeding areas for many wading birds and a valuable nursery area for juvenile fish and invertebrates, including many of commercial interest. Hardbottom areas exhibit soft and hard corals, marine algae and a host of colorful invertebrates and tropical fish.

The nearby islands are remnants of ancient coral patch reefs that emerged from the sea 10,000 years ago. The islands support lush growths of tropical hardwood hammocks, saltmarsh, buttonwood, and mangrove forests on their undisturbed shorelines. The Lignumvitae Key Aquatic Preserve was established for the purpose of maintaining this rich mosaic of natural resources so that their aesthetic, biological and scientific values may endure for the enjoyment of future generations.

According to the Lignumvitae Key State Aquatic Preserve Management Plan (Florida DNR, 1991d) primary impacts to the Preserve's resources include boating and fishing activities and poorly planned development. Boating related impacts involve prop dredging, siltation and groundings. In addition, high speed boating through the channel parallel to the south side of US 1 conflicts with other uses such as diving and vessel mooring. Fishing impacts include uncontrolled or excessive collecting pressure on tropical fishes and other marine life which may seriously alter species, age and size class distribution in the preserve. These activities may compromise the diversity and the long term stability of these environments in addition to detracting from others' enjoyment of the area by removing the colorful fish and invertebrates. Development impacts to the preserve are primarily related to septic effluent of nearby development and the degradation of nearshore water quality which may threaten the long term survival of the preserve's marine resources.

Biscayne Bay-Card Sound State Aquatic Preserve

The Card Sound portion of Biscayne Bay Aquatic Preserve is located between the southeast mainland of Florida and North Key Largo, in Dade and Monroe Counties. The Preserve includes approximately 17,000 acres of submerged lands and mangrove islands. One of the more intrinsic values of the Preserve is the habitat provided to large numbers of endangered, threatened and species of special concern. The land and water areas around the Sound are refuge for a diverse group of designated plants and animals that have been extirpated or excluded from the sprawling metropolitan area to the north and are under intense pressure from loss of habitat or disruption of feeding, nesting, and resting areas. Card Sound is a prime settlement and nursery site for a large variety of marine fauna. The importance of this area to juvenile spiny lobster (Panulirus argus) prompted the Florida DNR to designate the area as a Lobster Sanctuary.

According to the Biscayne Bay-Card Sound State Aquatic Preserve Management Plan (Florida DNR, 1991b), local activities that affect resources of the preserve include increased use by boaters, land development, mosquito control, and commercial harvesting of marine organisms. Boating impacts include prop scouring of grassbeds and the "shading out" of marine organisms associated with docking facilities. Land development may negatively impact water quality, vegetation, listed species, and the biological and aesthetic qualities for which the preserve was established. Septic leachate, injection well seepage, agricultural effluent and upland run-off contribute excessive nutrients (and other forms of pollution) to marine communities that are adapted to a low nutrient existence. Fish larvae, as well as marine and terrestrial invertebrates are extremely sensitive to Batex and malathion, which are the insecticides which are or have been used for mosquito control applications on north Key Largo. Commercial and amateur collecting and overharvesting of marine

life is also a potential problem in the preserve. Intensive collecting of a single species may eliminate that species from an area and may affect biological processes and community structure.

San Pedro Archaeologic Aquatic Preserve

The San Pedro Archaeologic Aquatic Preserve is located approximately south of Indian Key. The Preserve includes 72 acres of submerged lands, including the San Pedro shipwreck, and mooring buoys.

Coupon Bight State Aquatic Preserve

The Coupon Bight State Aquatic Preserve is located to the south of Big Pine Key and includes approximately 6,000 acres of submerged lands in Coupon Bight and the Atlantic Ocean. Coupon Bight is unique within the state system of Aquatic Preserves because it encompasses living coral reef formations. The submerged portions of the preserve encompass seagrass meadows, hard bottom communities, mangrove wetlands and coral patch reefs that provide nursery and settlement habitat for a wide variety of marine species.

According to the Coupon Bight State Aquatic Preserve Management Plan (Florida DNR, 1991c), the preserve is negatively affected by development on Big Pine Key. Since the preserve lies "downstream" of the urban and residential development on Big Pine Key, the destruction or disturbance of freshwater wetlands and subsurface fresh water lenses alters the water flow which is responsible for the presence of many of the unique and rare plant and animal species that occur in the area. In addition, pollution in the form of stormwater run-off and septic leachate are primary concerns in both freshwater and marine areas of the preserve.

Activities within the preserve include boating, snorkeling, diving, commercial fishing, marine life collecting, charter sport fishing and recreational fishing for finfish and lobster. According to the Management Plan (Florida DNR, 1991c), impacts to resources as a result of these uses include propeller and grounding damage to grassbeds and corals, damage to patch reefs from careless or uninformed divers who stand on or touch corals, extended boat anchoring which shades grassbeds, fishing and marine life collecting which introduce gear and chemicals that impact target and non-target species. Secondary impacts are associated with suspension of sediments in the water column associated with boat operation in shallow waters, individual personalized watercraft, ultra-light aircraft and private planes which disrupt wildlife, and chemicals and wastes introduced into waters of the preserve as a result of boat operation and maintenance.

North Layton Hammock CARL Project

The North Layton Hammock project includes 74 acres within its acquisition boundary on Long Key. Although the property has not been acquired, it is eventually to be managed as part of the Long Key State Recreation Area with emphasis on the preservation of the botanical resources. The site is predominantly comprised of wetland natural communities although the upland natural communities present are among the rarest in Florida. The rockland hammock, coastal berm, and rock barren natural communities harbor several threatened elements of Florida's tropical flora including the federally endangered Key tree cactus (*Cereus robinii*). The Florida DNR has indicated that recreational activities to be permitted must be fully compatible with the protection of the rare and sensitive biological resources, with nature trail walks, bird-watching, nature study and photography among the most appropriate uses.

Curry Hammock CARL Project

The Curry Hammock CARL Project includes 404 acres primarily consisting of rockland hammock and estuarine tidal swamp natural communities on Fat Deer Key. The project is one of the few undisturbed upland sites that remains in the Middle Keys and includes an outstanding example of palm hammock, a type of rockland hammock, which is very rare and poorly represented in the few other existing localities. Unusual geological formations help create an environment that supports these unique plant associations. Several rare and endangered plant and animal species are known from the project area.

The site is to be managed as a State Park or Preserve, with emphasis on passive recreation. A disturbed area on Little Crawl Key has been included in the project as a location for the development of recreation-oriented facilities and/or a potential site for active recreation such as improved camping.

Since the site is not yet in public ownership, it is still susceptible to development. In addition, the upland portions of the Curry Tract are extremely vulnerable to changes resulting from human activities such as wood collecting and trash dumping.

Coupon Bight/Key Deer CARL Project

The Coupon Bight/Key Deer CARL Project has identified land south of US 1 on Big Pine Key and bordering Coupon Bight to be acquired for Key deer habitat and to serve as a buffer for the Coupon Bight State Aquatic Preserve. Approximately 117 acres have been acquired to date with an additional 1,060 acres remaining to be acquired.

Cowpen's Rookery Preserve

The Cowpen's Rookery Preserve includes approximately 165 acres of submerged land near Plantation Key. This valuable rookery habitat is owned by the State of Florida but leased to and managed by the National Audubon Society.

Big Pine Key Save Our Rivers Project (SFWMD)

The South Florida Water Management District (SFWMD) acquires properties on Big Pine Key for water supply and flood protection purposes. Parcels must be designated wetlands in order to qualify for acquisition under the Save Our Rivers project. Approximately 190 acres have been acquired by the SFWMD on Big Pine Key, which eventually will be incorporated into the National Key Deer Wildlife Refuge.

C. County-Owned Conservation Lands

The Monroe County Land Authority has been acquiring environmentally-constrained lots throughout the Keys through fee simple purchases, donations and conservation easements since 1986. These are generally subdivision lots which were rendered unbuildable by the implementation of the 1986 Comprehensive Plan. The Land Authority owns approximately 500 acres of land throughout the Keys.

D. Privately-Owned Conservation Lands

A number of organizations purchase lands in Monroe County for conservation purposes. Table 3.24 lists lands owned by the Florida Keys Land and Sea Trust and The Nature Conservancy.

E. Measures to Protect Publicly-Owned Conservation Lands

While fee title acquisition by public agencies generally guarantees permanent protection of conservation lands from development, it does not ensure the long-term health and stability of the natural systems present on a property. Resource management on public lands typically first addresses land management issues which occur within the boundaries of a refuge, park, or special interest site. Secondly, issues related to activities off the property are considered. Increasingly, public agencies which own and manage conservation lands are becoming aware that in order to protect their resources, resource management activities must recognize and address in some fashion what is occurring on adjacent or nearby private properties. Depending upon the particular situation, the management issues on "adjacent lands" can be minor; in others, such as with spills of hazardous materials or unsightly land development activities, the impacts can seriously threaten the conservation values for which the property was protected.

DNR has recognized the problems of adjacent lands by establishing "greenline areas" around each of its units, including all of its parks in the Keys. The "greenline areas" are buffers of varying widths, drawn based upon a number of concerns which could affect resources within park boundaries. In the Keys, DNR has listed concerns which extend to adjacent lands related to water quality, groundwater withdrawals, pesticide use, biting insect control, shoreline and substrate alteration, critical habitat area protection, removal of invasive plants, and prescribed burning. These designations have been provided to Monroe County and to state agencies for use in local comprehensive planning and permitting.

Monroe County should support the conservation efforts of state and federal agencies by working cooperatively with resource managers at the publicly-owned refuges, parks and sites of particular interest to address adjoining lands issues. The County, in cooperation with the appropriate state and/or federal agencies, should identify a Conservation Land Protection Area for each conservation area owned by the federal and state governments in the Keys. These areas should include:

- (a) private lands located within existing park and conservation land boundaries (i.e., private inholdings); and
- (b) private lands and county-owned lands within a designated buffer adjacent to each conservation land.

Buffers should be designated on an individual case basis and should reflect the resource protection concerns, land development patterns, and land ownership specific to a particular conservation land. All conservation lands should be addressed, including submerged lands where there may be significant issues related to marine uses. To the extent that existing buffer areas have been identified by public agencies already, these should be adopted as the Conservation Land Protection Area, provided the County concurs with the designation.

Monroe County should initiate Conservation Land Protection Area planning efforts immediately in cooperation with appropriate state and/or federal agencies. However, due to the large number of conservation lands located in Monroe County and the complex relationship between land uses and potential impacts on natural resources, it will likely take several years to identify the land use activities which are causing, or have the potential for causing, adverse impacts on sensitive natural features and natural resources. Monroe County should strive to complete these planning efforts by September 30, 1995.

Working with the same state and federal agencies, Monroe County should develop a management plan for each Conservation Land Protection Area. These plans should identify actions to be taken by the County within the Conservation Land Protection Area in support of the purpose for which the area was acquired. These actions should include:

land management actions for private land and county-owned lands as they relate to critical species protection, invasive plant removal, restoration of disturbed wetland and upland habitat, pesticide application, prescribed burning, and any other activities which may have potential adverse impacts on nearshore water quality;

- (a) recommendations regarding permitting of shoreline structures, dredging and filling, and substrate alteration;
- (b) actions to maintain and/or improve public access to public conservation lands;
- (c) strategies for working cooperatively with private landowners in support of conservation; and
- (d) future intergovernmental coordination with state and/or federal agencies controlling and/or managing the conservation land.

Management plans should be reviewed every three years and revisions made as necessary to reflect recent land acquisitions and changing management priorities.

3.18.3 Units of the Coastal Barriers Resources System

The Coastal Barrier Resources Act (CBRA) of 1982 established the Coastal Barrier Resources System (CBRS). The CBRA legislation is specifically designed to restrict federally subsidized development of undeveloped coastal barriers in order to minimize the loss of human life, reduce the wasteful expenditure of Federal revenue, and reduce damage to fish and wildlife habitat and other valuable natural resources of coastal barriers (U.S.D.I., 1988). Specifically, the CBRA prohibits within the undeveloped, unprotected coastal barriers of the CBRS, most expenditures of Federal funds which encourage development. The intent of the CBRA is to remove from undeveloped coastal barriers Federal incentives for new development, such as National Flood Insurance, structural stabilization projects, and Federal assistance for construction of sewer systems, water supply systems, airports, highways, and bridges (U.S.D.I., 1988).

CBRA defines a coastal barrier as a depositional feature that is subject to wave, tidal, and wind energies and that protects landward aquatic habitats from direct wave attack. As such CBRA extends the definition of an undeveloped coastal barrier to encompass all associated aquatic habitats, including adjacent wetlands, marshes, estuaries, inlets and nearshore waters. This definition reflects the specific conservation purposes of the CBRA to protect the fish, wildlife, and other natural resources of coastal barriers (U.S.D.I., 1988).

Today, the CBRS is comprised of undeveloped coastal barriers along the Atlantic and Gulf of Mexico coasts, including the coasts of the Florida Keys, Puerto Rico and the Virgin Islands. The CBRS includes fifteen units located within the Florida Keys. Table 3.21 identifies the Keys' CBRS units under the category of "marine resource areas of particular concern". The Comprehensive Plan Map Atlas shows the CBRS units on the Existing Land Use Maps.

Most of the CBRS units in Monroe County are largely undeveloped. They include four subdivisions with IS, CFV or URM zoning. These zones encompass 82 vacant lots, five of which are characterized by undisturbed salt marsh and buttonwood wetlands.

In general, future development in the County should be directed to the maximum extent possible away from the fifteen CBRS units. This should be accomplished through land use policies of the Comprehensive Plan and its implementing land development regulations. In developing the Permit Allocation System for implementation of the Plan, consideration should be given to assigning a negative point to developments proposed in CBRS units (see Future Land Use Chapter Section 2.4.1.B).

Other actions which Monroe County should take to discourage further private investment in CBRS units include:

- (a) no new bridges, causeways, paved roads or commercial marinas should be permitted to or on CBRS units;
- (b) shoreline hardening structures should not be permitted along shorelines of CBRS units;
- (c) public expenditures on CBRS units should be limited to property acquisition, restoration and passive recreation facilities;
- (d) privately-owned undeveloped land located within the CBRS units should be considered for acquisition by Monroe County; and
- (e) Monroe County should coordinate with FKAA and private providers of electricity and telephone service to assess measures which could be taken to discourage extension of facilities and services to CBRS units.

3.19 Effects of Future Land Use on Natural Resources

The Goals, Objectives and Policies of the Comprehensive Plan (see Policy Document) and the accompanying Land Development Regulations will alter both the rate and distribution of growth so

as to ensure that future patterns of land use in Monroe County reflect three critical land use determinants. These include:

- (a) carrying capacity limitations;
- (b) natural resource protection; and
- (c) enhancement of community character.

Protection of the natural resources of the Florida Keys is accomplished through several growth management measures in the Plan, summarized as follows:

- (a) reduction in the rate of residential and non-residential development;
- (b) prohibition of new development in all wetlands (exclusive of disturbed salt marsh and buttonwood wetlands); and
- (c) direction of new development away from sensitive upland areas and areas where impacts of development would adversely affect wildlife species designated by FWS as threatened and endangered.

Other major features of the Comprehensive Plan adopted for purposes of environmental protection include implementation of the following:

- (a) an aggressive program for public acquisition of environmentally sensitive lands;
- (b) adoption of revised Land Development Regulations including more stringent environmental design criteria;
- (c) implementation of measures designed to reduce over the long-term pollutant discharges into ground and surface waters;
- (d) development and implementation of a Sanitary Wastewater Master Plan and Stormwater Management Plan for the County;
- (e) implementation of measures to protect threatened and endangered species;
- (f) an aggressive program for restoration of county-owned lands and for promotion of voluntary restoration of privately-owned lands; and
- (g) cooperative planning efforts with state and federal agencies for private lands adjacent to and within publicly-owned conservation lands.

3.19.1 Natural Resource Protection by Reducing Growth Rates

As discussed in Section 2.4.1 of the Future Land Use Chapter, the determination of carrying capacity is measured based upon the following key public capacity limitations:

- (a) the levels of service established in the Comprehensive Plan for the six public facility types described in Section 2.1.9 (roads, potable water, solid waste, sanitary sewer, drainage, and parks and recreation); and
- (b) the requirement that hurricane evacuation times for incorporated and unincorporated Monroe County be maintained at or below 30 hours.¹

Analysis of levels of service for the six public facilities and hurricane evacuation times has indicated that the critical carrying capacity constraint at this time is hurricane evacuation time. Application of this constraint has established the available development capacity in unincorporated Monroe County at 2,552 units. Distributed over the planning timeframe, this amounts to 255 units per year. Included in the definition of "units" are single family residential, multi-family residential, hotel/motel units, mobile homes and recreational vehicle spaces.

This level of available development capacity, established in the Comprehensive Plan, is well below that which would have occurred under the current plan on the basis of projected populations and associated demand for housing. The amount of new residential and non-residential development which will be permitted by the Plan during the ten years from 1993 through 2002 will be approximately 40 percent of what would have occurred under existing conditions without plan adoption. This amounts to a reduction of approximately 4,226 residential units and 922,000 square feet of commercial development over the same ten year period.

The reduced growth rate over the next ten years will have several beneficial impacts on the biological communities and waters of the Florida Keys. Most significant will be the reduction in the rate of habitat loss as a result of construction of 4,226 fewer residential units and 922,000 fewer

¹ At this time it is not possible to accurately address "environmental carrying capacity" as a public capacity limitation in the planning process. It is evident that Monroe County's biological communities and nearshore waters have suffered impacts of man's activities, including habitat loss and environmental contamination. At present, scientific data are not available to support an assessment of the carrying capacity of these resources to absorb additional impacts of man without suffering further irreversible damage. Nearshore and offshore water quality degradation has been proposed as a measure of environmental carrying capacity, expressed as the amount of anthropogenic pollutant loading that can be absorbed before the living marine resources - the mangroves, seagrass beds and coral communities - of the Keys show evidence of irreversible decline. Assessments recently completed for the Phase I Florida Keys National Marine Sanctuary (FKNMS) Water Quality Protection Program (CSA, 1992) (see Section 3.5.2 above) have concluded that there is a relative paucity of data presently available to assess the water quality of the Keys as well as the impacts of degraded water quality on living marine resources. This is due to the lack of well designed, long-term studies (CSA, 1992). Several research programs are under consideration which will provide the baseline data needed to model "environmental carrying capacity" (see Section 3.5.6 above). These will be undertaken by federal and state agencies, with participation by Monroe County, upon implementation of the Florida Keys National Marine Sanctuary Management Plan in the summer of 1993. Until such studies are completed, a measure of "environmental carrying capacity" cannot be used to establish limitations on growth in the Keys.

square feet of commercial development. Secondly, there will be a reduction in pollutant loads to the waters of the Florida Keys associated with 9,300 fewer residents and visitors.

3.19.2 Natural Resource Protection by Prohibiting Development in Wetlands

The Comprehensive Plan prohibits new residential and non-residential development in most wetlands in the Keys. This prohibition applies to the following wetland communities:

- (a) mangroves;
- (b) submerged lands;
- (c) undisturbed salt marsh and buttonwood wetlands;
- (d) beaches (50 feet from all natural shorelines); and
- (e) freshwater wetlands (disturbed and undisturbed).

Prohibition of development in undisturbed salt marsh and buttonwood wetlands is the major new wetlands protection element of the Comprehensive Plan. Assuming the worst case, Monroe County's current Land Development Regulations would have allowed construction of as many as 2,250 dwelling units in the remaining undisturbed salt marsh and buttonwood wetlands of the Keys (Monroe County BOCC, 1991a). This development would have had associated with it disturbance of up to 15 percent of the total remaining undisturbed wetland area, representing a potential loss of wetland habitat of as much as 675 acres. In actuality, the area of impact would have likely been significantly greater than 675 acres due to the indirect impacts of development, such as alteration of tidal flow, OSDS contamination of groundwater, introduction of invasive plants, and residential activities which expand into adjacent undisturbed wetlands.

Development in disturbed wetlands will continue to be allowed, subject to permits from COE, DER and Monroe County and new permitting policies of the County (see Section 3.19.4 below).

3.19.3 Natural Resource Protection by Directing Growth away from Sensitive Areas

In accordance with the Plan, growth in the Keys over the next ten years will be allocated in equal annual increments of 255 units per year. The Permit Allocation System will distribute this growth on the basis of explicit performance criteria implemented through a point system adopted in the Land Development Regulations concurrent with plan adoption.

In general developments located and designed so as to provide the greatest public benefit will have the greatest chance of being permitted in a given year. Several "negative" points are under consideration which would serve to:

- (a) direct growth away from the Coastal High Hazard Area;
- (b) direct growth away from sensitive natural areas, including:

- (1) high quality hardwood hammocks and pinelands;
- (2) undisturbed beach/berms;
- (3) habitat areas of certain federally-designated wildlife species (see Section 2.4.1 D of the Future Land Use Chapter);
- (4) offshore islands;
- (5) units of the Coastal Barrier Resources System; and
- (6) Conservation Land Protection Areas (see Section 3.18.2.E).

"Positive points" under consideration would:

- (a) encourage the use of wastewater treatment and disposal methods which will reduce pollutant loads to groundwater;
- (b) reduce urban sprawl; and
- (c) encourage development on already disturbed and scarified lands.

In order to successfully compete for a building permit over the next ten years it will be necessary to minimize the number of negative points and maximize the number of positive points associated with a development. Based on the environmental protection criteria under consideration for the Point System, this Permit Allocation System will serve first to permit growth in existing improved subdivisions, where biological communities have already been disturbed, and where measures are taken in project design to reduce nutrient loads in wastewater discharges. Given the annual limit of 255 new units, the probable allocation of growth to improved subdivisions may very well use up most if not all of the allocation for a given year. This will in turn reduce further habitat losses in the remaining undisturbed tropical hardwood hammocks, beach/berms, and pinelands throughout the Keys and will generally protect all native wildlife species.

3.19.4 Natural Resource Protection through Stronger Environmental Design Criteria

When development is permitted under the Comprehensive Plan it will be subject to revised and strengthened environmental design criteria of the new Land Development Regulations.

Effective with completion of the Advance Identification of Wetlands (ADID) Program in the Keys, anticipated by September 30, 1993, Monroe County will implement a permitting program for activities in disturbed wetlands subject to a "no net loss" of functional value policy. While this will allow some filling of disturbed salt marsh and buttonwood wetlands, it will eliminate any further net loss of wetland function in the Florida Keys.

Several revisions to existing regulations will better protect native upland pinelands and tropical hardwood hammocks and wildlife habitat. Most important, the existing Habitat Evaluation Index will better distinguish between high, medium and low quality habitat, with emphasis on proper recognition of high quality habitat. Clustering requirements, bulk regulations, and development standards will be tightened to further reduce disruption to native habitats on development sites. Permitted clearing on development sites will be restricted to the immediate development areas, which will be fenced throughout the duration of construction. Development will not be permitted to

disturb champion trees, specimen trees or federally-designated plant species. The County will require replacement or transplantation of mature native vegetation disturbed by development.

3.19.5 Natural Resource Protection through Land Acquisition

Fee title acquisition of real estate is the most effective means of protecting environmentally sensitive lands from direct disturbances by human activities. Elements of the Comprehensive Plan which will reduce the rate of growth and direct the allocation of growth, will discourage development in many undisturbed upland communities and habitat areas of federally-designated species. However, these techniques will not permanently guarantee protection of these sensitive ecological resources. This will best be accomplished through acquisition by the federal, state or local government, or by a non-profit conservation organization, for permanent conservation purposes. While acquisition is not a realistic solution for most lands in the Keys, it should be pursued aggressively for those which are determined by County staff, local scientists, and regulators to be the most ecologically sensitive and the most susceptible to development or environmental threat, despite the protections afforded by the Comprehensive Plan.

The Comprehensive Plan calls for establishment of the Monroe County Natural Heritage and Park Program. The sole purpose of this program will be to acquire land and open space in the public interest for conservation and recreation purposes. It will target for acquisition critical areas identified in the Plan which lie outside of the project limits of ongoing state and federal acquisition programs. The types of lands to be acquired and the general organizational guidelines for the Program are discussed above in Section 2.4.1.F of the Future Land Use Chapter.

3.19.6 Implementation of Measures to Reduce Pollutant Discharges into Ground and Surface Waters of the Keys

Several factors suggest that future pollutant loadings in the Florida Keys will decrease by the Year 2010. Population growth rate reductions resulting from plan implementation will generally result in lower than predicted nutrient loadings as modeled in previous studies (Camp Dresser & McKee, 1990). Loadings are expected to be further reduced through adoption of nutrient effluent and/or water quality standards. County water quality levels of service, particularly for OSDS nutrient removal, are expected to become more strict following completion of the Sanitary Wastewater Management Plan and the Stormwater Management Master Plan. Other programs targeting specific nutrient loading sources of Monroe County, combined with state and federal actions resulting from implementation of the Florida Keys National Marine Sanctuary Program are also expected to further reduce loadings from all sources.

The Comprehensive Plan includes goals, objectives and policies (GOP's) to reduce pollutant discharges into ground and surface waters from point and non-point sources. These GOP's outline the specific actions to be taken by Monroe County to protect estuaries and nearshore waters. They are found under Goal 202 of the Comprehensive Plan Policy Document. Policies are included which address water quality impacts from:

- (a) on-site disposal systems;
- (b) secondary sewage treatments plants;
- (c) live-aboard vessels;

- (d) marinas and fueling facilities;
- (e) seafood processing facilities;
- (f) recreational boating;
- (g) dredge and fill operations;
- (h) stormwater runoff;
- (i) erosion and sedimentation;
- (j) pesticide applications;
- (k) aboveground and underground storage tanks; and
- (l) hazardous wastes.

Also included are policies regarding the County's participation in studies and programs of the Florida Keys National Marine Sanctuary Water Quality Protection Program, the County's participation in the SWIM Planning Process, and special investigations regarding water quality in artificial canals and plugged waterways.

Several special plans and studies are either ongoing or planned in the next few years by Monroe County. Several of these will provide background data, identification of trends and problems, and recommendations for regulatory and policy revisions related to specific land uses which affect water quality.

3.19.7 Development and Implementation of a Sanitary Wastewater Master Plan and Stormwater Management Plan for Monroe County

The most important studies planned by Monroe County to protect the waters of the Florida Keys will be the Sanitary Wastewater Master Plan and the Stormwater Management Plan. The Sanitary Wastewater Management Plan will make several recommendations which will have significant effects on anthropogenic nutrient loadings to nearshore waters. The Plan will recommend:

- (a) the ultimate type of treatment and effluent disposal system to be utilized by geographic service area within the County;
- (b) the mandatory levels of treatment for new and replacement systems, including the criteria for attaining the adopted level of treatment;
- (c) recommendations for retrofitting specific existing facility deficiencies found to be causing significant water quality degradation; and
- (d) recommendations for ongoing monitoring programs to assess the effectiveness of sanitary wastewater improvements and amended adopted levels of service on water quality.

The Stormwater Management Plan will also make several recommendations designed to reduce pollutant loadings:

- (a) recommendations for retrofitting specific existing facility deficiencies found to not be meeting the adopted levels of service standards; and

- (b) recommendations for ongoing monitoring programs to assess the effectiveness of stormwater management improvements and amended adopted levels of service on water quality.

Conclusions of both plans will be integrated into the Comprehensive Plan through the amendment process.

3.19.8 Protection of Threatened and Endangered Species

The Comprehensive Plan calls for an active protection program for federally-designated threatened and endangered plant and animal species. Foremost, are the establishment of routine data collection and analysis procedures for mapping ranges and specific occurrences of designated species. Recovery activities are proposed for each species, aimed at prohibiting its destruction and protecting its habitat. These are dependent upon the type of habitat utilized, the threats to that habitat, and the specific sensitivities of each species. The general types of recovery activities include:

- (a) assignment of negative points in the Permit Allocation System;
- (b) recommended habitat acquisition through the Monroe County Natural Heritage and Park Program;
- (c) revisions to the Habitat Evaluation Index for purposes of better reflecting habitat value to wildlife, particularly designated species;
- (d) stepped up enforcement of existing laws pertaining to free-roaming pets, road speeds in critical habitat areas, and molesting or harming of endangered species;
- (e) increased coordination preservation efforts between the County and FWS, FGFWFC and DNR.

A program for protection of state-designated species and locally rare plants and animals is also called for in the Plan.

3.19.9 Restoration of Disturbed Habitats

The Comprehensive Plan includes three major provisions for restoration of disrupted marine, beach/berm, and native upland vegetation. The Plan calls for an ongoing restoration program for public lands. Restoration needs are to be identified every other year, with consideration given to nearshore marine, wetland, beach/berm, and native upland habitats. Priority will be given to implementation of restoration projects on public beaches. The County will seek a combination of local, state and federal funds to implement specific projects, including but limited to monies paid to the County as fines or penalties for environmental crimes, or as payments in lieu of replacement of native vegetation destroyed during the land development process.

The restoration program for private lands is comprised of two components. Mandatory removal of invasive plants from all development sites will be required prior to issuance of a certificate of occupancy. The County will pursue development of incentives and use of volunteer organizations for purposes of promoting voluntary removal of invasive plants from private property.

3.19.10 Cooperative Planning Efforts to Protect State and Federal Conservation Lands

The Comprehensive Plan commits Monroe County to a new cooperative planning program with resource managers at publicly-owned refuges, parks, and sites of particular interest in the Keys (see Section 3.18.3.E above). This planning program will address management issues related to activities on adjoining private lands which may be adversely affecting, or have the potential to adversely affect, the natural resources for which the refuge or park was established to protect. Implementation of this program will further ensure the long-term health and stability of the natural systems of conservation lands in the Keys by reducing encroachments and environmental degradation due to activities on adjoining lands which remain in private ownership.

3.20 Existing Land Use in the Coastal Area

All of Monroe County is located within the coastal area. Therefore, the inventory of existing land uses included in Section 2.1 (Future Land Use Element) represents the inventory of existing land uses within the coastal area (see Chapter 2.0). This section addresses land use along Monroe County's shoreline including:

- a) water-dependent and water-related uses;
- b) conflicts among shoreline uses; and
- c) recommended studies to address the need for water-dependent and water-related uses and other issues related to shoreline development.

3.20.1 Existing Water-Dependent Uses

A. Water-Dependent Uses

According to Rule 9J-5, water-dependent uses are "activities which can be carried out only on, in or adjacent to water areas because the use requires access to the water for: waterborne transportation, recreation, electric generation or water supply" [9J-5.003(101)]. In Monroe County, the majority of water-dependent uses are related to commercial fishing or recreation activities. Other water dependent uses include the City Electric Power Plant on Stock Island and military facilities of the US navy and the Coast Guard. Table 3.25 detail public and privately owned water-dependent uses in Monroe County. Water-dependent uses listed in the table include commercial fishing facilities (docks, marinas), recreational facilities (beaches, waterfront parks, marinas, fishing piers and boat ramps), military uses, and water-dependent utilities. The locations of these facilities are illustrated on the Water-Related and Water-Dependent Uses map series of the Map Atlas.

B. Water-Related Uses

According to Rule 9J-5, water-related uses are "activities which are not directly dependent upon access to a water body, but which provide goods and services that are directly associated with water-dependent or waterway uses" [9J-5.003(103)]. These uses include boat storage, marine repair, retail boat and trailer sales, marine industrial (boat building, boat yards, hull work and painting, marine construction) tropical fish collection and sales, fish houses (wholesale and retail fish sales,

processing, and packaging), commercial fishing support (trap storage, building and dipping), ship stores, bait and tackle stores, and dive shops. The location of those facilities are illustrated on the Water-Dependent and Water-Related Map series of the Map Atlas.

3.20.2 Conflicts Among Shoreline Uses

A. Competition for Shoreline Development Sites

The diminishing supply of shoreline development sites is a major source of conflict among competing land uses. The demand for waterfront land comes not only from water-dependent and water-related uses described above, but from commercial, residential and tourism related uses attracted to waterfront locations by economic or aesthetic reasons rather than by functional necessity.

The physical beauty of the waters surrounding the Keys induces an overwhelming preference for shoreline rather than inland locations. The growth and importance of the tourism industry and the rising seasonal and permanent residential population (discussed in section 2.1.7, Economic Conditions and Section 2.2, Population Projections of the Future Land Use Element) has increased the demand for waterfront sites for residential, recreational, and tourist-related commercial development which are not water-dependent. In addition, public agencies have increased efforts to acquire and preserve shoreline areas for recreation and conservation uses. Physical characteristics and more stringent environmental regulations further limit areas suitable for marina and docking facilities.

Despite the extensive shoreline of the Keys, the supply of shoreline development sites cannot satisfy the demand. In this competitive market, water-dependent/water-related uses are often supplanted by more profitable non- water-dependent or water-related uses. Tourism, which continues to dominate the local economy in terms of employment, depends heavily on access to the shoreline for recreational uses. The increasing number of recreational boats has heightened the competition for suitable marina sites between commercial fishing and recreational marina operators.

Some of the decline in the number of commercial fishing vessels can be attributed to less dock space, higher dockage fees and the rising cost of living in the Keys (see Section 2.1.7 of the Future Land Use Element, Economic Conditions). During the period 1980-1990, the number of commercial fishing boats declined 6 percent while the number of pleasure boats have increased 67 percent. This increased demand for recreational marinas has squeezed the supply of commercial fishing marinas and increased the pressure to redevelop commercial fishing marinas for recreational marina use.

Conflicts also occur where adjacent shoreline uses are incompatible. The potential for conflict is greatest among water-dependent or water-related uses which may be perceived as nuisance producing (commercial fishing and support facilities, boat storage, marine repair, marine industrial, fish houses) and uses reliant on the scenic quality and amenity provided by a shoreline location (recreational, residential, tourist-related services). The noise, smells and visual character of some water-dependent/water-related uses may be undesirable to adjacent tourist, residents, and recreation users. Often, existing water-dependent/water-related uses do not become troublesome until newer residential and commercial uses locate on adjacent sites. The harborside area in Marathon is one of many existing locations where conflicts result from residential uses sited adjacent to commercial fishing uses.

Table 3.25

Water Dependent Uses

Location	Map Ref. #	Name	Facilities							Parking	Public Access	Ownership
			Marina	Boat Ramp	Fishing Pier	Commercial Fishing Dock	Beach	Waterfront Park	Other			
North Key Largo	1	Angler's Club	1							1		Private
North Key Largo	2	Caryfort Yacht Club	1							1		Private
North Key Largo	3	Ocean Reef Club	1	1						1		Private
Key Largo	4	American Outdoors Marina	1				1			1		Private
Key Largo	5	Anchorage Resort & Yacht	1							1		Private
Key Largo	*6	Atlantic Blvd		2						1		County
Key Largo	7	Atlantis Marina	1							1		Private
Key Largo	8	Bay Harbor	1	1					Boat Basin	1		Private
Key Largo	*9	Blue Fin Marina	1							1		Private
Key Largo	10	Blue Lagoon Motel	1									Private
Key Largo	11	Blue Waters Marina	1							1		Private
Key Largo	12	Calusa Camp Resort	1	1					Boardwalk	1		Private
Key Largo	13	Campbell's Marina	1							1		Private
Key Largo	14	Campbell's Cove Trailer Park	1	1						1		Private
Key Largo	15	Capt. Jax	1							1		Private
Key Largo	16	Coastal Waterway Trailer Park	1	1						1		Federal
Key Largo	17	Cross Key	1	1						1		Private
Key Largo	18	Cross Key Marina	1							1		Private
Key Largo	19	Cross Key Waterways Estates		1								Private
Key Largo	20	Curtis Marine	1							1		Private
Key Largo	21	Deep Six Marina	1							1		Private
Key Largo	22	Garden Cove Marina	1							1		Private
Key Largo	23	Gilbert's Marina	1	1						1		Private
Key Largo	24	Hammer Point Park		1								County
Key Largo	25	Hibiscus Park						1		1		Private
Key Largo	26	Hideaway Motel	1									Private
Key Largo	27	Holiday Inn Marina	1									Private
Key Largo	28	Island Bay Resorts	1									Private
Key Largo	29	Island Houseboat Rental	1									Private
Key Largo	30	Italian Fisherman Marina	1									Private
Key Largo	31	J. Ron's Marina	1							1		Private
Key Largo	32	John Pennkamp Coral Reef Park	1	1			1	1		1		State
Key Largo	33	Jules (Koblick) Marine	1							1		Private
Key Largo	34	Key Largo Ocean Marina		1			1			1		Private
Key Largo	35	Key Largo Beach						1				County
Key Largo	36	Key Largo City		1			2			1		Private
Key Largo	37	Key Largo Kampground		1								Private
Key Largo	38	Key Largo Mobile Home Sites		1				1				Private
Key Largo	39	Key Largo Ocean Shores					1			1		Private
Key Largo	40	Key Largo Sheraton	1									Private
Key Largo	41	Key Largo Village		1				1				Private
Key Largo	*42	King's Kampground										Private
Key Largo	43	Lake Largo	1							1		County
Key Largo	44	Largo Sound Park Club		1					Boat Basin, Tiki			Private
Key Largo	45	Lime Grove Estates		1						1		Private
Key Largo	46	Manatee Bay Marina	1									Private
Key Largo	47	Marina del mar Resort	1									Private
Key Largo	48	Marina del Rey	1									Private
Key Largo	49	Ocean Divers Marina	1	1								Private
Key Largo	50	Ocean Isle Estates		1					Docks	1		Private

Table 3.25
Water Dependent Uses

Location	Map Ref. #	Name	Facilities							Parking	Public Access	Ownership
			Marina	Boat Ramp	Fishing Pier	Commercial Fishing Dock	Beach	Waterfront Park	Other			
Plantation Key	101	Treasure Harbor Charter Yachts	1									Private
Plantation Key	102	Treasure Harbor		1								Private
Plantation Key	103	Venetian Shores		1								Private
Windley Key	104	Drop Anchor Motel	1									Private
Windley Key	105	Estate's Fishing Camp	1							1	1	Private
Windley Key	106	Harbor Lights	1									Private
Windley Key	107	Holiday Isle Resort	1	1								Private
Windley Key	108	Richmond's Landing, Inc.	1	1			1					Private
Windley Key	109	Sandbar Restaurant/Marina	1							1	1	Private
Windley Key	110	Tropical Reef Resort	1									Private
Islamorada	111	Bay Hammock		1								Private
Islamorada	112	Bayside Marine, Inc.	1						Wet storage	1	1	Private
Islamorada	113	Bud N Mary's Marina	1	1					Wet storage	1	1	Private
Islamorada	114	Caribee Outboard Marina	1							1	1	Private
Islamorada	115	Cheeca Lodge/Marina			1							Private
Islamorada	116	Coral Bay Marina	1	1					Wet storage	1	1	Private
Islamorada	*117	Islamorada Library	1	1					Picnic area			Private
Islamorada	118	Islamorada Yacht Basin/Lovetel	1	1								Private
Islamorada	119	Islander Resort	1	1			1					Private
Islamorada	120	Kor-Tiki Resort										Private
Islamorada	121	Matecumbe Marina		1			1			1	1	Private
Islamorada	122	Max's Marina	1					1		1	1	County
Islamorada	123	MM 81.5						1		1	1	County (11)
Islamorada	*124	MM 82.5	1	1						1	1	Private
Islamorada	125	Papa Joe's Marina		1								Private
Islamorada	126	Pen Key Club		1					Boardwalk			Private
Islamorada	127	Pines/Palms Marina		1								Private
Islamorada	128	Sea Isle Resort	1									Private
Islamorada	129	Sunset Inn	1	1								Private
Islamorada	130	Whale Harbor Resort	1				1					Private
Lignumvitae Key	131	State Botanical Site							Dock, trails, observation tower	1	1	State
Indian Key	132	MM 78		1					Ferry to Lignumvitae Key	1	1	FDOT
Indian Key	133	State Historic Site		1					Dock, trails, observation tower	1	1	State
Lower Matecumbe	134	Boy Scout Sea Base	1	1	1			1	Boardwalk			Private
Lower Matecumbe	135	Caloosa Cove Resort	1							1	1	FDOT
Lower Matecumbe	136	Channel Five Catwalk			1					1	1	FDOT
Lower Matecumbe	137	Channel Two Catwalk										Private
Lower Matecumbe	*138	Garnetfish Resort	1	1			1	1	Boardwalk	1	1	Private
Lower Matecumbe	*139	Lower Matecumbe Beach							Bikepath			Lease to Cnty
Lower Matecumbe	140	Robbie's Boat Rentals	1							1	1	Private

Table 3.25

Water Dependent Uses

Location	Map Ref. #	Name	Facilities							Parking	Public Access	Ownership
			Marina	Boat Ramp	Fishing Pier	Commercial Fishing Dock	Beach	Waterfront Park	Other			
Lower Matecumbe	*141	Sea Oats Beach	1						Nature preserve			Private
Lower Matecumbe	*142	Tropic Air Resort	1		1		1		Boardwalk			Private
Lower Matecumbe	143	Topside Resort	1						Boardwalk	1	1	Private
Fiesta Key	144	KOA Campground	1	1			1		Bait & tackle	1	1	Private
Long Key	145	Bird Marina	1						Canoe trails	1	1	Private
Long Key	146	Edgewater Marine	1					1		1	1	State
Long Key	147	Long Key State Recreation Area										Private
Long Key	148	Outdoor Resorts	1	1		1						Private
Conch Key	149	Conch Key Marinas										Private
Duck Key	150	Duck Key Marina	1									Private
Duck Key	151	Hawk's Cay Marina	1	1								Private
Grassy Key	152	Bonefish Harbor/Gulfside 59	1	1								Private
Grassy Key	153	Coco Palms	1				1					Private
Grassy Key	154	Jolly Roger Travel Park	1	1			1		Boardwalk			Private
Grassy Key	155	Lion's Lair	1	1								Private
Grassy Key	156	Pelican Motel	1	1								Private
Grassy Key	157	Rainbow Band Resort	1	1			1			1	1	Private
Fat Deer Key	158	Bonefish Marina	1			1						Private
Fat Deer Key	159	Coco Plum Marinas										Private
Fat Deer Key	160	Coral Lagoon Resort	1									Private
Fat Deer Key	161	Driftwood Harbor	1						Boat repair	1	1	Private
Fat Deer Key	162	Hawaiian Village Hotel	1	1					Pump out			Private
Fat Deer Key	163	Marie's Yacht Harbor	1							1	1	FDOT
Fat Deer Key	164	MM 54		1					Fish camp	1	1	Private
Fat Deer Key	165	The Boat House	1							1	1	Private
Marathon	166	Anchor Lite Motel	1							1	1	County
Marathon	167	Aviation Blvd.										Private
Marathon	168	Banana Bay Resort	1	1								Private
Marathon	169	Becker Marine	1									Private
Marathon	170	Blue Waters Resort										Private
Marathon	171	Boot Key Marina	1							1	1	Private
Marathon	172	BP Surfside Gulf	1	1								Private
Marathon	173	Bucanier Lodge Resort	1				1		Boardwalk	1	1	Private
Marathon	174	Capt. Hook's Marina	1							1	1	Private
Marathon	*175	Capt. Pip's Marina	1						Docks	1	1	Federal
Marathon	176	Coast Guard Station	1									Private
Marathon	*177	Coral Lagoon Resort	1							1	1	Private
Marathon	178	Fero Blanco Marine Resort	1	1								Private
Marathon	179	Fishermen's Pointe	1									Private
Marathon	180	Galway Bay Mobile Home	1	1								Private
Marathon	*181	Gulf Stream Travel Park	1									Private
Marathon	182	Hells Resort	1						Dive Center	1	1	Private
Marathon	183	Harborside Marina	1									Private
Marathon	*184	Hawk's Cay	1	1						1	1	Private
Marathon	185	Hidden Harbor Motel	1									Private
Marathon	186	Hurricane Resort	1									Private
Marathon	187	Key Lime Resort & Marina	1	1								Private
Marathon	*188	Key Trailer Courts	1							1	1	Private
Marathon	189	Key Vaca Marina	1						Boat Rental	1	1	Private
Marathon	*190	Keys Boat Works	1						Boat Repair	1	1	Private

Table 3.25
Water Dependent Uses

Location	Map Ref.#	Name	Facilities						Parking	Public Access	Ownership
			Marina	Boat Ramp	Fishing Pier	Commercial Fishing Dock	Beach	Waterfront Park			
Marathon	191	Kingsail Motel	1	1					1	1	Private
Marathon	192	Marathon Boat Yard	1					Boat Yard			Private
Marathon	193	Marathon Seaford				1					Private
Marathon	194	Marathon Trailrama	1								Private
Marathon	195	Marathon Yacht Club	1						1	1	Private
Marathon	*196	Ocean Isle Fishing Resort	1					Boardwalk			Private
Marathon	197	Ocean Isle Fishing Village		1				Boat Repair	1	1	Private
Marathon	198	Oceanside Marina Services	1						1	1	Private
Marathon	199	Old Seven Mile Bridge			1			Boat & Tackle	1	1	Private
Marathon	200	Pinehills Marina Goods	1								Private
Marathon	201	Seashore Lagoon Resort	1								Private
Marathon	202	Seascope resort	1								Private
Marathon	203	Sombrero Marina	1						1	1	Private
Marathon	204	Swilick Park (Sombrero Beach)									County
Marathon	205	The Reef Resort	1		1						Private
Marathon	206	Vac Cut Motel	1	1							Private
Marathon	207	Whinner Docks	1						1	1	Private
Hog Key	208	Hog Key Marina		1				Boat Yard	1	1	Private
Boat Key	209										Private
Knight Key	210	7 Mile Marina		1		1		Boat Rental	1	1	Private
Knight Key	211	Hawk's Nest Condo	1								Private
Knight Key	212	Knights Key Park & Marina	1	1			1		1	1	County
Little Duck Key	213	North & South US 1		1							FDOT
Missouri Key	214	South US 1, MM 40			1			Roadside pulloff	1	1	Private
Ohio Key	215	Sunshine Key Camping Resort	1	1			1		1	1	State
Bahia Honda Key	216	Bahia Honda State Park		1			1				Private
West Summerland	217	Camp Sawyer (Boy Scout)		1				Waterfront camp			Private
West Summerland	218	Camp Wesumkee (Girl Scout)		1				Waterfront camp			Private
West Summerland	219	Spanish Harbor Wayside Park		1	1				1	1	FDOT
West Summerland	220	Bahia Shores/Dolphin Harbor				1		Residential			Private
No Name Key	221	Big Pine Fishing Lodge	1	1					1	1	Private
Big Pine Key	222	Big Pine Shores				1		Residential			Private
Big Pine Key	223	Eden Pines		1							Private
Big Pine Key	224	Haleycon Beach Trailer Park	1								Private
Big Pine Key	*225	Kemp Channel, MM 23.5			1			Dry storage	1	1	FDOT
Big Pine Key	226	Keys Sea Center, Inc.	1	1					1	1	Private
Big Pine Key	227	Koehn Road		1					1	1	County
Big Pine Key	228	Mariner Resort & Marina	1	1			1				Private
Big Pine Key	229	Old Wooden Bridge			1				1	1	County
Big Pine Key	230	Old Wooden Bridge Fish Camp	1	1							Private
Big Pine Key	231	Outward Bound						Boat docks			Private
Big Pine Key	232	Palm Villa					1		1	1	County
Big Pine Key	233	Port Pine Heights									Private
Big Pine Key	234	Seacamp Association	1	1							Private
Big Pine Key	235	Dolphin Marina	1	2					1	1	Private
Little Torch	236	Old SR 4		1							County
Little Torch	237	Parmer's Place	1	3							Private
Little Torch	238	Little Palm Island (Munson Island)						Docks			Private
Newfound Harbor	239	Looe Key Resort		1							Private
Ramrod Key	240	Near MM 26				1		Residential			Private

Table 3.26

Water Dependent Uses

Location	Map Ref.#	Name	Facilities							Parking	Public Access	Ownership
			Marina	Boat Ramp	Fishing Pier	Commercial Fishing Dock	Beach	Waterfront Park	Other			
Sumterland Key	241	Kamp Channel Bridge							Docks	1	1	State
Sumterland Key	242	Sumterland Estates Park		1								Private
Sumterland Key	243	Sumterland Key Cove		1								Private
Sumterland Key	244	Sumterland Key Marina				1						Private
Sumterland Key	245	Sumterland Marina							Charter dockage Residential Dive Shop	1	1	Private
Cudjoe Key	246	Bluefish Canal	1							1	1	Private
Cudjoe Key	247	Cudjoe Gardens Marina		1						1	1	County
Cudjoe Key	248	Cudjoe Road		1								Private
Cudjoe Key	249	Venture Out		1								Private
Cudjoe Key	250	Indian Mounds		1								Private
Sugarloaf	251	KOA Campground & Marina	1	1			1		Bait & Tackle	1	1	Private
Sugarloaf	252	Sugarloaf Lodge Marina	1	2			1			1	1	FDOT
Shark Key	253	MM 11.5		1								Private
Big Coppitt	254	Caribbean Village	1									County
Big Coppitt	*255	Delamir Blvd.		1								Private
Big Coppitt	256	Gulfcast		1								Private
Big Coppitt	257	Seaside Resort	1	1						1	1	Private
Geiger Key	258	Geiger Key Marina	1	2						1	1	FDOT
Geiger Key	259	Boca Chica Bridge Approaches			1					1	1	County (11)
Boca Chica	*260	SR 941					1					Private
Stock Island	261	Boyd's Campground	1	1						1	1	Private
Stock Island	262	Capt. Billy & Key West Diver	1									Private
Stock Island	263	City Electric Power Plant								1	1	Private
Stock Island	264	Cow Key Marina		1								Private
Stock Island	265	First Key West Marina								1	1	Private
Stock Island	*266	Leo's Campground	1	1						1	1	Private
Stock Island	267	MM 5		1						1	1	FDOT
Stock Island	268	Murphy's Marina	1							1	1	Private
Stock Island	269	Murray Marina		1						1	1	Private
Stock Island	270	Oceanside Marina	1	1								Private
Stock Island	271	Peninsular Marina										Private
Stock Island	272	Safe Harbor										Private
Stock Island	*273	Sunset Harbor Trailer	1	1						1	1	Private
Stock Island	274	US 1 Marina		1						1	1	Private
Stock Island	275	Hight Beach Park			1				Bait & Tackle	1	1	County
Key West		Total Facilities	159	140	12	9	41	24		117	119	

Note: Map Reference #'s with a (*) indicate that location of the facility is uncertain and does not appear on the Water Related and Water Dependent Map series of the Map Atlas.

(1) Property leased to Monroe County

Source: Monroe County Growth Management Division

Increased shoreline development, which may contribute to the destruction of marine habitats and decrease in fish populations, conflicts with commercial fishing activities which are dependent on marine resources and conservation uses which attempt to protect and preserve marine resources. Some active recreational activities (motor boating, water-skiing and jet-skiing) can potentially damage marine resources valued by other recreational activities (scuba/snorkeling, recreational fishing) as well as commercial fishing. Water-dependent recreation uses present a different conflict. Friction between active and passive recreational uses can occur where shared recreational facilities do not allow adequate separation.

C. Live-Aboards

A live-aboard is defined as an individual(s) whose continuous residence is a boat, not necessarily at a fixed location, for a period of more than two months. Live-aboards use their boats as private primary or secondary residences for extended periods. The total number of live-aboard boats in the Keys is estimated to be 1,410 boats, housing some 3,000 residents. Live-aboards include a large number of permanent and seasonal residents. The most common type of live-aboard boat is a sailboat comprising 69 percent of the total. Approximately 70 percent of live-aboard vessels are found at shoreside sites (marinas, clubs, boat yards, piers, seawalls) and 30 percent of live-aboards anchor in coastal waters. Shoreside live-aboard sites are found throughout the Keys where anchorages tend to be concentrated. Over half of the anchorages are in Boot Key Harbor in the Middle Keys. Other major anchorage locations are Cow Key Channel and Christmas Tree Island in the Lower Keys, which account for 27 percent of the anchorages.

Service Demands of Live-Aboards

Although live-aboards technically reside on water, they rely on a number of dockside services (dockage, toilets, showers, laundry, telephone, mail, ice, refrigeration, parking, dingy dockage, a pump-out), commercial services (stores, restaurants), and community services (medical, dental, fire, police and education). According to a survey of live-aboards, services most often sought include:

- (a) improved dockside facilities;
- (b) showers and restrooms;
- (c) sewerage pump-out facilities;
- (d) recreation; and
- (a) public dingy dockage (Antonini et. al., 1990)

Conflicts Between Live-Aboards and Land Residents

There are six locations where single family homes are located in close proximity to concentrations of live-aboards: Pine Channel, Boot Key, Key Colony, Coco Plum, Key Largo Beach and Port Lido Canal. Escalating conflicts in Boot Key Harbor area, where there is a high concentration of live-aboards, led to harbor blockades by live-aboards and boarding of live-aboards vessels by law enforcement agencies (Antonini et. al., 1990).

Live-aboards are commonly perceived by shore residents as transients who degrade the coastal environment and contribute little to the coastal community. Live-aboards complain of the noise generated by recreational boaters and restricted access to the shore. Major areas of conflict include:

- (a) access from the live-aboard boats to the shoreline;
- (b) disposal of kitchen and sanitary wastes;
- (c) abandonment of vessels
- (d) location, crowding, and appearance of live-aboard vessels;
- (e) live-aboard settlement rights and preemptive uses of water space;
- (f) surveillance of live-aboard activities by local authorities;
- (g) general impact of live-aboards on the scenic and ecological qualities of the waterfront;
and
- (h) appropriate fees for live-aboards services.

Both shore residents and live-aboards rank sewerage as the number one waterfront problem. Sanitary wastes is disposed of by one or more methods: overboarding by flushing, holding tank storage and shoreline pump-out, and/or onboard pretreatment and discharge. It is estimated that less than 10 percent of the live-aboards use sewerage pump-out facilities. In 1983, Monroe County attempted to address the sewerage problems caused by live-aboards. The Marine and Port Advisory Board designated Boot Key Harbor as a water management area and attempted to attract a private company to provide the following for-fee

services to live-aboards: pump-out, garbage collection and showers. The program could not be implemented because no bids were received (Antonini et. al., 1990).

3.20.3 Need for Water-Dependent and Water-Related Uses

Currently, the County has insufficient information available to estimate the need for appropriate sites for water-dependent and water-related uses. The inventory contained in Table 3.25 does not include information needed to estimate current or projected future demand.

Marinas, Boat Ramps and Commercial Fishing Docks

In order to determine the need for additional marinas and boat ramps, the County must establish the capacity of the existing facilities. A Marina Study is needed to record the following information for each of the 159 marinas, 9 commercial fishing docks and 140 boat ramps listed in Table 3.25:

- (a) number of wet and dry slips;
- (b) usage rates of wet and dry slips;

- (c) breakout of slips by boat size;
- (d) on-site amenities including the number of parking spaces;
- (e) surrounding uses and any known or potential compatibility problems;
- (f) availability for public use (recreational marinas only);
- (g) number of boats provided and the boat lanes for each ramp;
- (h) conditions of facilities;
- (i) existing DER-accepted documentation of water quality trends
- (j) availability of pump-out facilities; and
- (k) potential for marina expansion according to siting criteria (see below).

In general, marinas should be sited where the optimum physical characteristics are maximized and impacts on marine resources are minimized. Therefore, the County should develop specific criteria for marina siting which are consistent with DER Rule 17-312 F.A.C., DNR Rule 18-21.004 F.A.C., and regulations of the US Corps of Engineers.

The marina siting criteria should consider:

- (a) benthic vegetation and faunal assemblages;
- (b) adequacy of circulation and tidal flushing;
- (c) access to deep water through existing channels of adequate depth;
- (d) minimal shoreline modification necessary;
- (e) quality and size of upland area and degree of alteration necessary;
- (f) ability to restore and enhance marina resource values at sites subject to past alteration;
and
- (g) location of propeller dredging problem areas.

Beach and Shoreline Access

The County does not have sufficient information regarding the existing capacity of the 41 beaches, 12 fishing piers, and 24 waterfront parks listed in Table 3.25 or the usage rates for these facilities. A Public Access Plan will be undertaken to evaluate the existing and future needs for access points to the beach and shoreline and supporting parking facilities (see section 3.23, Public Access Facilities).

Live-Aboard Study

In the future Monroe County, with the assistance of the Marine and Port Authority, will need to address the following items in order to resolve the conflicts created by the live-aboard lifestyle, not only in Boot Key Harbor, but throughout the Keys:

- (a) criteria for siting live-aboards mooring areas;
- (b) potential locations of live aboard mooring areas;
- (c) sanitation requirements;
- (d) maximum vessel allowances in live-aboard mooring areas;
- (e) registration, fee structure and method of fee collection for live-aboard moorings;
- (f) propose definitions of live-aboard status
- (g) identify pollutant loadings from live-aboards;
- (h) identify need for private and public pump-out facilities; and
- (i) developing permitting, inspection and enforcement procedures to reduce pollutant discharges in surface waters.

Shoreline Priorities Plan

Ultimately, the detail information provided by the Marina Study and marina siting criteria, docking facilities siting criteria, the Public Access Plan and the Live-Aboard Study can be used in the development of a Shoreline Use Priorities Plan which will address issues related to water-dependent and water-related uses. The Shoreline Use Priorities Plan should:

- (a) assign higher priority to water-dependent and water-related uses of shoreline sites than to other uses;
- (b) establish performance standards for shoreline development;
- (c) identify vacant or redevelopable sites where the maximum physical advantages exist for water-dependent/water-related uses and where no unreasonable or excessive impacts are foreseen on marine resources;
- (d) recommend strategies for reserving such sites for water-dependent and water-related uses to satisfy the estimated need for such sites;
- (e) recommend strategies to eliminate conflicts among existing shoreline uses and to encourage mixed use development which includes water-dependent/water-related uses that are compatible with existing land uses; and
- (f) maintain existing commercial fishing operations as conforming uses.

3.20.4 Areas in Need of Redevelopment in the Coastal Area

All of Monroe County is located within a coastal area. Therefore, the areas in need of redevelopment in the coastal area are identical to those identified in Section 2.4.3 of the Future Land Use Element (Need for Redevelopment).

3.21 Analysis of the Economic Conditions and Trend of the Coastal Area

All of Monroe County is located within the coastal area. Therefore, the economic conditions and trends of the coastal area are identical to those identified in Section 2.1.7 of the Future Land Use Element (Economic Conditions and Trends).

3.22 Natural Disaster Planning

3.22.1 Hurricane Evacuation Planning

A. Introduction

A guiding principle of growth management and comprehensive planning is the protection of the public health, safety and welfare. The most common catastrophic threat to public safety in the coastal areas of the Florida is the potential loss of life and property from storm surge, flooding and high winds associated with hurricanes. Nowhere in Florida is this hurricane threat as grave as it is in the Florida Keys. This is due to the elongated configuration of the Keys, resulting in a 112-mile long evacuation route, plus the probability of total inundation by the hurricane storm surge. This threat is fact, not speculation. The severity of the threat is such as to preclude any policy option other than evacuation to the mainland, particularly when faced with a Category 3 to 5 hurricane.

Under Florida's Growth Management Law hurricane evacuation is not a concurrency factor, nor are levels of service mandated for hurricane evacuation. Nevertheless Rule 9J-5.012(3)(b)7 mandates that the comprehensive plans "maintain or reduce" hurricane evacuation (clearance) time.

In the Comprehensive Plan Preliminary Policy Direction of February 4, 1991, the Monroe County Board of County Commissioners (BOCC) determined that the Comprehensive Plan should establish as a policy that hurricane evacuation clearance times, then estimated to be 34 hours, be reduced to 30 hours. It is acknowledged that a hurricane evacuation clearance time of 30 hours is less than ideal. Because the National Weather Service typically issues hurricane warnings some 12 to 24 hours prior to landfall, a clearance policy time of 30 hours would necessitate that evacuation orders be issued prior to the declaration of hurricane warnings. Nevertheless, establishment of a hurricane evacuation clearance policy as a basis for determining an enforceable carrying capacity is an important policy milestone for Monroe County. In furtherance of this policy, the BOCC in August 1991 directed that the Card Sound Road be used for evacuation to the mainland in addition to the primary route US 1. An additional outbound lane was thereby obtained, increasing evacuation time capacity and reducing clearance times below the standard of 30 hours.

Both Card Sound Road and the portion of US 1 outbound from Key Largo (MM 106 to MM 126, the "18-mile stretch") are low-lying and vulnerable to flooding. Therefore, elevating and widening

the 18-mile stretch of US 1 is of critical importance to reduce the vulnerability to flooding of this vital link to the mainland. This improvement will not directly enhance evacuation capacity or reduce clearance times.

Monroe County's specific emergency response procedures are detailed in the Monroe County Hurricane Preparedness, Evacuation and Shelter Plan (1991). This plan outlines the procedures and protocols for coordinating emergency response and evacuation procedures, and is incorporated in the Coastal and Conservation Management Element by reference. However, it is not discussed in detail in this section because the procedures contained in the plan are continuously updated and refined to ensure that emergency response procedures remain current, flexible, and sufficient to meet the demands of a storm event.

B. Hurricane Vulnerability

Monroe County's subtropical location, extensive shoreline, and proximity to the Caribbean Sea in an area of high hurricane activity make it among the most hurricane vulnerable areas in the United States. Hurricanes are defined as tropical cyclonic disturbances with winds in excess of 115 kilometers per hour. Most hurricanes form between 5 and 20 degrees latitudes in all tropical oceans except the South Atlantic and eastern South Pacific (Monroe County Department of Emergency Management, 1991). One of the greatest threats posed by hurricanes are their erratic and irregular tracks, making prediction of landfall difficult. Between 1886 and 1987, 43 tropical storms of hurricane intensity have passed within 125 miles of Marathon, with an average of one storm within a 125 mile radius every 2.4 years (NOAA, 1987). Hurricanes are most common in Monroe County in September and October, although they have occurred in all months between June and November. Of the 43 recorded hurricanes that have occurred within 125 mile of Marathon, 22 have been classified as major (Category 3, 4, or 5) on the Saffir-Simpson Scale, which measures hurricane intensity based upon wind speed and barometric pressure (see Table 3.26).

Damage caused by hurricanes can be divided into three categories: wind damage, storm surge and inland freshwater flooding. The most devastating damage is caused by storm surge. Storm surge is responsible not only for a large proportion of coastal property damage, but also for 90 percent of hurricane-caused deaths. Storm surge occurs along a 65 to 80 kilometer long dome of water caused by high winds near the storm's center that can strike the coast near where the eye, or center, of the hurricane makes landfall. Storm surge is the height of water above normal tide level, with wind-driven waves super-imposed on the surge. Storm surge is caused when water that is displaced by wind-driven water on the surface can no longer be dissipated because of the shallow depths near shore, so that water builds up and moves with the storm as it approaches land. The island nature of the Keys, and large areas of coastline along both Florida Bay and the Atlantic Ocean, make Monroe County vulnerable to the impacts of storm surge from both water bodies.

Table 3.26
Saffir/Simpson Hurricane Intensity Scale

Category	Central Barometric Pressure (millibars)	Central Barometric Pressure (inches)	Wind Speed (MPH)	Wind Speed (Knots)	Likely Damage
1	>980	>28.94	74-95	64-83	Minimal
2	965-979	28.50-28.91	96-110	84-96	Moderate
3	945-964	27.91-28.47	111-130	97-113	Extensive
4	920-944	27.17-27.88	131-155	114-135	Extreme
5	<920	<27.17	>155	>135	Catastrophic

Source: Monroe County Department of Emergency Management

The storm surge associated with any one storm is difficult to predict, since the surge is a factor of the strength of the hurricane, its direction and speed, and the tide period when it makes landfall. In order to predict the possible effects of storm surge, the National Hurricane Center has developed a complex computer model known as SLOSH, Sea and Lake Overland Surge from Hurricanes. The SLOSH model maps for Monroe County are valuable for indicating areas that may be affected by storm surge. However, they cannot be used as predictive tools for identifying areas that would be impacted by a particular storm event.

The Hurricane Vulnerability Zone is defined by Rule 9J-5 as:

“areas delineated by the regional or local hurricane plan as requiring evacuation. The hurricane vulnerability zone shall include areas requiring evacuation in the event of a 100-year storm or Category 3 storm event” (9j-5.003(41)).

This definition would place all of Monroe County, including the mainland, in the Hurricane Vulnerability Zone. The mainland is included because it serves as part of the Lake Okeechobee drainage basin, and flooding is anticipated if the lake was impacted by a hurricane. As a result of the entire County being located within the Hurricane Vulnerability Zone, the population at risk is defined as all county residents and seasonal population. This “functional population” is the basis of the calculation of hurricane evacuation clearance times for the County. The functional population is defined and discussed below.

C. Hurricane Evacuation Considerations

One of the most critical elements of a hurricane evacuation is the route to be used by evacuees. From Key West to Key Largo (MM 106), US 1 provides the only route out of the County. At MM 106, partial diversion of the traffic to SR 905 (Card Sound Road) can occur. Many portions of both US 1 and Card Sound Road are low-lying, and therefore prone to flooding. Fifty-eight points have been identified along US 1 between MM 7.5 and MM 112.6 that are below 7 feet National Geodetic Vertical Datum (NGVD) (see Table 3.27). Elevations as low as 1.5 feet NGVD occur on Card Sound Road. The presence of these low points necessitates early evacuation of the County in

advance of the arrival of a hurricane. For this reason, the elevation of low-lying portions of these roadways should be undertaken to ensure safe evacuation of County residents.

The Monroe County Comprehensive Plan Hurricane Evacuation Analysis, prepared by Post, Buckley, Schuh & Jernigan, Inc., provides an analysis of hurricane evacuation via US 1 and Card Sound Road, including an estimate of the clearance times required to evacuate Monroe County using these roadways. This study establishes evacuation zones, identifies critical roadway segments, and estimates clearance times based on existing development patterns, functional population, and the behavioral analysis undertaken as part of the Lower Southeast Florida Hurricane Evacuation Study prepared by the US Army Corps of Engineers in 1989.

Clearance time is the time required to clear the roadways of all vehicles evacuating in response to a hurricane threat. Components of clearance time include:

- (a) the time necessary for evacuees to secure their homes and prepare to leave, referred to as mobilization time;
- (b) the time spent by evacuees on the roadway network, referred to as travel time; and
- (c) the time spent waiting in congested conditions in the roadway system, referred to as queuing delay time.

Clearance time **does not** reflect the time any one vehicle is expected to spend traveling on the roadway system out of the Keys.

The results of the Hurricane Evacuation Analysis are summarized below. This analysis plus the policy for clearance time set by the Board of County Commissioners provides the basis for establishing the critical carrying capacity constraint on the amount of future growth that can be accommodated within Monroe County (see Chapter 2.0, Future Land Use Element).

Table 3.27

U.S. Highway 1 Elevation Below Seven Feet NGVD in Monroe County

Location by Key	Mile Marker	Elevation (NGVD)	Landmark
Boca Chica	7.5	6.5	
Big Coppitt	10.5	5.6	
Saddlebunch #3 Bridge	13.6	6.5	
Saddlebunch #3 Bridge	14.1	6.5	West end of bridge
Lower Sugarloaf	17.0	6.6	
Lower Sugarloaf	17.4	6.6	
Upper Sugarloaf	20.0	6.0	
Cudjoe	21.0	6.0	
Cudjoe	21.3	6.0	Post Dr.
Cudjoe	23.0	6.0	Cutthroat Dr.
Ramrod	27.0	6.0	Coral Ave.
Ramrod	27.3	6.0	Indies Dr.
Ramrod	27.5	6.0	
Torch Ramrod Bridge	27.7	6.0	
Middle Torch	27.9	6.0	Mid. Torch key Rd.
Torch Channel Bridge	28.0	6.0	West end of bridge
Big Pine	31.5	5.3	St. Peter's Church
Vaca	48.0	5.5	15th St.
Vaca	49.5	6.5	47th St.
Vaca	49.7	6.5	52nd St.
Vaca	50.0	6.5	
Vaca	51.0	6.5	
Vaca	51.5	6.0	Marathon Shores
Vaca	52.0	6.0	Marathon Shores
Fat Deer	54.0	6.5	
Grassy	57.5	6.0	
Grassy	58.0	5.5	
Grassy	58.5	6.5	
Long	66.0	5.5	
Long	66.5	6.0	
Long	67.0	6.0	
Long	67.5	6.0	
Long	68.0	5.5	
Long	68.5	5.5	
Long	69.0	6.0	
Lower Matecumbe	74.0	5.0	
Lower Matecumbe	74.5	5.5	
Lower Matecumbe	75.0	5.5	
Lower Matecumbe	75.5	5.5	

Location by Key	Mile Marker	Elevation (NGVD)	Landmark
Lower Matecumbe	76.0	6.0	
Lower Matecumbe	77.0	6.5	
Upper Matecumbe	83.5	6.0	CR-905
Windley	84.5	5.5	CR-905
Key Largo	106.5	5.5	
Key Largo	107.0	5.0	
Key Largo	107.5	6.0	
Cross	108.0	5.0	
Cross	108.5	5.0	
Cross	109.0	5.5	
Cross	109.5	5.5	
Cross	110.0	6.0	
Cross	110.5	5.5	
Cross	111.0	5.5	
Cross	111.5	5.5	
Cross	112.0	5.5	
Cross	112.5	5.5	County Line
Cross	112.6	5.5	

Source: Monroe County Emergency Management, 1990

The Approach

The analytical basis for measuring carrying capacity based on hurricane evacuation begins with a projection of probable clearance times as determined by the characteristics of the evacuating population and the capacity of the roadway system. This projected clearance time, when compared with the hurricane evacuation clearance time policy of 30 hours, yields a "reserve clearance time." This reserve is then translated into quantity of population and related residential and hotel/motel development that can be absorbed within the critical constraints of roadway capacity and clearance time policy.

The principle tool used to perform the complex simulation of hurricane evacuation in the Keys is a computer model developed by the firm of Post, Buckley, Schuh & Jernigan, Inc. under contract to the Jacksonville District of the US Army Corps of Engineers as part of the Lower Southeast Florida Hurricane Evacuation Study. Evacuation timing data developed for the Keys in the early eighties was updated in 1989 based on more recent hazards data, permanent and seasonal population figures, behavioral information, and transportation modeling techniques. The most recent hurricane evacuation model run, conducted on October 1991 as part of the comprehensive planning process, input Census-based 1990 population figures as well as the variables and assumptions described below. Factors considered in estimating the County's hurricane evacuation clearance times include:

- (a) pre-landfall hazards time;

- (b) clearance time;
- (c) mobilization time;
- (d) travel time;
- (e) queuing time;
- (f) tropical storm winds time;
- (g) surge roadway inundation time;
- (h) issuance of local hurricane evacuation advisory; and
- (i) eye landfall.

Hurricane Evacuation Variables and Assumptions

The computer model used to calculate clearance times addresses a number of factors related to the conditions which will influence the process of evacuation under hurricane conditions. Key factors and the assumptions made for them are as follows:

Area of Evacuation

Although it is conceivable that depending on the path and severity of a particular hurricane only a portion of the Keys might be evacuated, the model assumes that all of the keys will be evacuated during a Category 3 to 5 storm.

Participation Rates

Based upon behavioral surveys, participation rates (e.g., the proportion of residents and tourist who can be expected to evacuate during a hurricane) vary by location and by type of dwelling (see Nelson et. al., 1989). The participation rates for seasonal units and mobile homes were assumed to be 95 percent. Based on the results of the Southeast Florida Hurricane Evacuation Study, participation rates for all other residential units (primarily occupied by permanent residents) are assumed to be 60 percent for the Lower Keys, 80 percent for the Middle Keys, and 85 percent for the Upper Keys.

Population

The analysis of hurricane evacuation times which was prepared in 1989 assumed a 1990 resident population of 79,300 for all of Monroe County plus an estimated additional seasonal population of 48,700 persons. Hurricane evacuation computer model analyses conducted in October 1991 were based upon 1990 Census data and assumed a permanent population of 78,024 persons and more detailed and accurate estimates of seasonal population totaling 56,643 persons.

Response Time

Evidence shows that the response of affected population can vary somewhat depending on a variety of factors. An average or medium response time was assumed in the hurricane evacuation analysis.

Seasonal Occupancy

The total 1990 functional population of the Keys is estimated to be 134,667 of which 56,643 are seasonal residents and visitors to Monroe County. These seasonal residents and tourist are categorized as follows:

Seasonal Households	25,040
Tourists (Hotel/Motel & Campgrounds)	21,026
Live-aboard vessels	2,498
Persons visiting friends/relatives	8,079

These seasonal population figures reflect the peak occupancy rates for each category. While it is assumed that 95 percent of tourists and seasonal residents will evacuate, it is not clear what proportion of this peak seasonal population can reasonably be expected to be in the Keys when a general evacuation order is given. The hurricane evacuation study conducted in 1989 indicated the following:

“...the level of seasonal occupancy varies during the hurricane season. The level appears to vary between a high of 75 percent of seasonal units and a low of 45 percent of seasonal units during the hurricane season. An additional occupancy assumption of 0% was tested under the premise that all hotels/guest houses and tourist accommodations will strictly adhere to the policy of issuing evacuation orders upon official posting of a hurricane watch.” (Post, Buckley, Schuh & Jernigan, 1989)

The testing of a 0% occupancy scenario highlights an important point. The County's evacuation plan calls for tourists to leave the Keys in advance of the general population. If the entire tourist population adhered to this policy of early evacuation, there would be no tourists left to hinder the evacuation of the general population. Thus, the tourist variable has two dimensions: the level of occupancy at the time a hurricane approaches and the extent to which that tourist population participates in an early evacuation.

Of the four components of seasonal population outlined above, the tourist portion is the easiest measure. The publication "Trends in the Hotel Industry" (Pannell Kerr Forster, 1992) identified an average occupancy of 74% in Monroe County during the 1991 hurricane season. Assuming the tourist component is representative of the other components of seasonal population, this average would support using the 75% scenario employed in the 1989 hurricane study. However, this conclusion assumes the County's plan to evacuate tourists ahead of time will be ineffective.

The recent evacuation due to Hurricane Andrew provided an opportunity to gather more detailed data. A Monroe County Planning Department survey of virtually the same accommodations as those studied in the Pannell Kerr Forster report indicates that tourist occupancy during the three days prior to the general evacuation ranged from 84% to 90%. These figures are considerably higher than last season's average of 74%, reflecting the Keys' popularity during the last summer weekend before school begins. The survey also reports that the tourist occupancy at the time the general evacuation order was given averaged 36%, indicating that a significant portion of the tourists did, in fact, leave early. Assuming, as before, that the tourist component is representative of the other components of seasonal

population, this more detailed survey supports using the 45% scenario employed in the 1989 hurricane study.

This factor of percent of peak seasonal occupancy should be the subject of additional data analyses simultaneous with additional studies of behavioral response and other key variables affecting the calculation of hurricane evacuation clearance time. Such updated data should then be input to run additional hurricane evacuation clearance models as a key element in the 1998 Comprehensive Plan update.

Table 3.28

Survey of Hotel Occupancy in the Keys Before, During, and After Hurricane Andrew

	Thursday Aug. 20 Night	Friday Aug. 21 Night	Saturday Aug. 22 Night	Sunday Aug. 23 6:00 AM	Sunday Aug. 23 11:00 AM	Sunday Aug. 23 Night	Monday Aug. 24 Night
Upper & Middle Keys							
Tourist	70%	86%	72%	50%	3%	0%	0%
Employees	0%	0%	0%	0%	0%	2%	1%
Locals	0%	0%	0%	0%	0%	0%	0%
Lower Keys							
Tourist	94%	98%	94%	77%	30%	17%	15%
Employees	0%	0%	1%	0%	1%	17%	10%
Locals	0%	0%	0%	0%	5%	11%	2%
All Keys							
Tourist	86%	90%	84%	79%	22%	12%	10%
Employees	0%	0%	0%	0%	0%	12%	0%
Locals	0%	0%	0%	0%	4%	8%	0%

Average tourist occupancy when the order to evacuate the general population was given:

Upper & Middle Keys (August 23 @ 6 AM) = 50%

Lower Keys (August 23 @ 11 AM) = 30%

Average of All Keys = 36%

Note: Based on a survey of 24 motels and hotels (over 3500 total rooms) in the Keys conducted September 14-21, 1992 by the Monroe County Planning Department.

Storm Intensity

The hurricane model assumes the threat of a Category 3 to 5 storm, which requires the evacuation of all of the Florida Keys. The severity of this threat precludes the use of shelters as an alternative to evacuation.

Vehicles per Unit

While hurricane evacuation pertains to the need to evacuate persons, the critical measure of the ability to evacuate related more directly to the number of vehicles which can move within the constraints of the roadway capacity. Thus, the estimated vehicle occupancy rate

and the assumed number of vehicles per dwelling unit which will evacuate are critical factors. The number of vehicles per unit varies significantly by type of unit and less so by location, ranging from 2 vehicles per unit for permanent residences in the Upper Keys to 1.04 vehicles per unit for tourist accommodations in the Lower Keys.

Outbound Travel Lanes

Comparable in importance to the number of people and vehicles to be evacuated is the capacity of the roadway system to accommodate the evacuating vehicles, as determined by the number of outbound (northbound) travel lanes. Based on established hurricane evacuation procedures, it is assumed that one southbound lane will always remain open for emergency vehicles. Therefore, all present two lane sections of US 1 are assumed to provide one outbound lane. With the use of only one outbound lane on US 1 present hurricane clearance time is calculated to be 35 hours assuming a 45% of maximum visitor occupancy. However, if 40% of outbound traffic were directed to Card Sound Road, this second lane of outbound traffic could reduce present hurricane evacuation clearance time to 24.75 hours. This is virtually the same reduction in clearance time which will be achieved with the widening of the 18 mile stretch of US 1. However, in order to realize the short-term effectiveness of the use of Card Sound Road in reducing hurricane evacuation clearance times the following conditions must be met:

- (a) There must exist significant traffic control in place for traffic diversion to Card Sound Road and for removal of disabled vehicles.
- (b) Citizens of Monroe County must have confidence that Card Sound Road is a viable evacuation route which can be gained through education efforts coupled with improvements to Card Sound Road as described below.
- (c) Card Sound Road elevations must be raised. At present time the elevation of the lowest point on Card Sound Road (2 feet MSL) could flood prior to the arrival of sustained tropical storm winds, or about 12 to 16 hours before landfall of the eye of a Category 4 hurricane. Under such conditions Card Sound Road would not function as a viable evacuation route. However, when the lowest point on Card Sound Road is raised to 5 feet MSL, flooding would occur during a Category 4 hurricane some 6 to 7 hours before landfall, thus greatly expanding its viability as an evacuation route.

Although the raising of Card Sound Road will reduce clearance times it remains critically important that action be taken to improve the 18-mile stretch of US 1 out of the Keys in order to minimize reliance on Card Sound Road and improve reliability and flexibility during hurricane evacuations.

Results

As summarized in Table 3.28 the number of units developable while maintaining the Year 2002 evacuation clearance time policy of 30 hours has been calculated for a scenario which incorporates two lanes outbound from Key Largo. In the short range these two outbound lanes are made available by the use of an improved and raised Card Sound Road plus the existing US 1. In the long range the time outbound lanes will be provided by a widened US 1 along the 18 mile stretch.

The calculation begins with the Year 2000 clearance time policy of 30 hours. From this factor is subtracted "actual clearance time" based on 1990 population rates and other factors cited above to yield a "reserve clearance time." Again it should be noted that this reserve clearance time is only made available by the use of a second outbound lane on an improved and raised Card Sound Road in order to reduce the present clearance time of 35 hours with one outbound lane to 24.75 hours with two outbound lanes. To this reserve of 5.25 hours is applied a factor which reflects the additional number of developable units per hour of reserve clearance time. This additional "units per hour" factor is adjusted to reflect an estimated average participation rate of 80% for future residents. The result is an estimated 5,780 additional developable units, including permanent, seasonal and hotel/motel units for the unincorporated area as well as for the municipalities. It must be noted that these measures of carrying capacity do not reflect additional development potential at plan adoption. Rather, they reflect the increase in population and development from April 1, 1990, the date of the 1990 census, data for which formed the starting point for estimating the population to be evacuated. Thus in order to determine the amount of development which the plan may allocate from the point of adoption, it is necessary to estimate the number of permitted units which will be issued between April 1, 1990 and October 16, 1992 and ultimately acted upon. Subtracting this estimate of 2087 permitted units leaves a net allocable growth of some 3693 units. A preliminary allocation to the municipalities of 1145 units is then subtracted leaving a net allocable growth for unincorporated Monroe County of 2548 units, or 255 units per year for 10 years.

As described in Section 2.4.1, Monroe County will implement measures to 1) allocate this remaining capacity over a ten-year period through a Permit Allocation System, and 2) initiate an interlocal agreement between unincorporated Monroe County and the three municipalities. The interlocal agreement will apportion the remaining development during the ten-year planning period among the four jurisdictions.

Implementation of measures such as capacity improvements to US 1 (e.g. widening of the section between MM 80 and MM 90) as well as behavioral factors such as vehicle occupancy rate increases will be required to further reduce hurricane evacuation clearance time below 30 hours beyond Year 2002 to 24 hours by 2010. The computer model should be periodically reapplied when warranted by new information such as implementation of roadway capacity improvements, new behavioral data, or substantial changes in development patterns to provide an up-to-date assessment of growth capacity based upon hurricane evacuation clearance times.

Table 3.29**Estimated Carrying Capacity Based on Hurricane Clearance**

Present Clearance Time	35 hours
2002 Clearance Time Policy	30 hours
Present Improved Clearance Time (1)	24.75 hours
Reserve Clearance Time	5.25 hours
Developable Units/hr (2) X	1101 units
Developable Units (3)	5780 units
Estimated Units at Adoption (4)	(2087) units
Estimated Units Allocable at Plan Adoption (5)	3693 units
Proposed Allocation to Municipalities (6)	(1145) units
Net Allocation for Unincorporated Monroe County	2548 units
Annual Ten Year Rate	255 units

Note:

- (1) Clearance time for all of the Keys with the use of Card Sound Road upon completion of improvements to provide a second outbound lane.
- (2) Calculated by applying 1145 evacuating vehicles per hour to an average of 1.3 evacuating vehicles per unit to indicate 881 evacuating units per hour then factored by an estimated 80% future participation rate to produce an estimated 1101 developable.
- (3) Includes permanent, seasonal and hotel/motel units for unincorporated Monroe County and incorporated cities.
- (4) Estimate of permits resulting in completed units in unincorporated Monroe County for the period 10-21-91 to 10-16-92 based on permits granted from 4-1-90 to 10-21-91.
- (5) Includes allocations for the unincorporated cities since April 1, 1990 and future allocations for hotel/motel units as well as single and multi-family residential units for all of Monroe County after plan adoption.
- (6) Preliminary proposed allocation to municipalities representing approximately 20% of total gross allocable growth or 31% of net allocable growth. Subject interlocal agreements.

D. Hurricane Shelters

While County policy mandates that 100 percent of County residents and visitors be evacuated to the mainland prior to arrival of a category 3 or greater hurricane, and evacuation is a wise action in the face of any hurricane threat, shelter and refuge must be provided as a contingency for those who may not leave. In addition, shelters within Monroe County must be provided during less severe Category 1 and 2 storms. During Category 3 or greater storm events these shelters will **not** be staffed, but will provide refuge for those residents who are unable to leave or who chooses not to leave after an evacuation order has been given.

The locations of and approximate capacities of existing hurricane shelters available for Monroe County residents are presented in Table 3.28. It should be noted that the number of shelter spaces

provided within Monroe County is highly variable and is monitored by the Department of Emergency Management. Facilities at the Tamiami campus of Florida International University (FIU) campus in Dade County have been designated for use by residents of Ocean Reef during a Category 1 or 2 storm event and by all Monroe County residents during a Category 3 or greater storm event.

Populations at risk are those who may be particularly vulnerable and require special assistance in a hurricane evacuation. In the Florida Keys this population with special needs includes non-ambulatory patients in hospitals and nursing homes, handicapped, live-aboard residents and transportation-disadvantaged persons. Monroe County Public Safety Division maintains an emergency evacuation registry within seven zones in the Florida Keys identifying special populations at risk, excluding hospitalized patients.

Table 3.30
Emergency Evacuation Registry

Zone	Area	Number of Registered Persons
1	Key West to MM 11.5	272
2	MM 11.5 to MM 40	80
3	MM 40 to MM 63	157
4	MM 63 to MM 83.7	29
5	MM 83.7 to MM 94	50
6	MM 94 to Card Sound Road	80
7	Ocean Reef Club	1
Total		699

Note: Registered persons are those persons who have requested transportation assistance in the event of an evacuation, including handicapped and transportation-disadvantaged persons.

Source: Monroe County Public Safety Division, August 1992

In addition to the registry of populations at risk, are the patients in the three Florida Keys hospitals, the combined census of which totals approximately 109 in-patients during hurricane season. Lower Florida Keys Health System (FKHS) in Key West has an average census of 75 patients, of which hospital administration estimates 60 would require evacuation assistance in the form of airlifting to St. Vincent's Hospital in Jacksonville with which Health Systems has an agreement to transfer patients. FKHS relies upon Monroe County Emergency Operations to provide this assistance.

Fisherman's Hospital maintains an average census of 18 patients and Mariner's hospital maintains an average census of 16 patients. In the event of an evacuation order, both hospitals discharge those ambulatory patients able to take responsibility for their own evacuation. For seriously ill patients and those unable to be discharged, both Fisherman's Hospital and Mariner's Hospital take responsibility for evacuation.

The Lower Southeast Florida Hurricane Study contains estimates of the population requiring shelter in Monroe County during a Category 1 or 2 hurricane and on the mainland during a Category 3 or

greater hurricane based upon behavioral analyses. These estimates are summarized in Tables 3.29 and 3.30.

Table 3.31
Hurricane Shelters

Shelter	Estimated Capacity Ranges	
	40 sf/person	20 sf/person
Monroe County Shelters		
Key West Federal Building, Key West	600	1,200
Glynn Archer School	700	1,400
Harris Elementary School	300	600
Mary Immaculate School	300	600
Sugarloaf VFD	100	200
Sugarloaf Elementary	150	300
Methodist Church Youth Center	110	220
AARP Building	75	150
Monroe County Library	100	200
Disabled American Veterans Building	100	200
Switlik Elementary	300	600
Coral Shores High School	1,000	2,000
Island Christian School	500	1,000
Plantation Key Elementary	75	150
Key Largo Elementary School	1,000	2,000
St. Justin Catholic Church	100	200
Subtotal Monroe County Shelters	5,510	11,020
Mainland Shelter		
FIU (Dade County): Ocean Reef Shelter (Zone 7) for categories 1 and 2; County shelter for Category 3 and higher	5,000	10,000

Note: 40 square feet per person reflects recommended occupancy standards although some shelters may acceptable accommodate evacuees at densities up to 20 square feet per person.

Source: Monroe County Civil Defense, 1985

Table 3.32
Monroe County Population Requiring Shelter during a Category 1 and 2 Hurricane

	Total Population	% of Population Requiring Shelter in Monroe County	Total Monroe County Shelter Spaces Required
Lower Keys	42,897	20%	8,579
Middle Keys	14,105	10%	1,511
Upper Keys	20,022	5%	1,001
Totals	78,024		11,091

Source: Monroe County Hurricane Preparedness Evacuation and Shelter Plan, 1991

Table 3.33

Monroe County Population Requiring Shelter during a Category 3 or Greater Hurricane

	% of Population Evacuating County	Population Evacuating County	% of Evacuating Population Requiring Shelter	Mainland Shelter Spaces Required
Lower Keys	90%	38,607	-	-
Middle Keys	90%	13,595	-	-
Upper Keys	100%	20,022	-	-
		72,224	20%	14,445

Source: Monroe County Hurricane Preparedness Evacuation and Shelter Plan, 1991; Regional Plan for South Florida, 1991

The inventory of hurricane shelter spaces indicates that 5,510 shelter spaces are available in Monroe County if a standard of 40 square feet per evacuee is used. Alternately, 11,020 spaces are available if a reduced standard of 20 square feet per evacuee is used. While 40 square feet is more comfortable and is therefore recommended, a standard of 20 square feet was used in Volume 12 of the Florida Keys Comprehensive Plan adopted by the Monroe County Board of County Commissioners and Approved by the Department of Community Affairs in 1986. Similarly, 5,000 spaces are available on the mainland at FIU based on 40 square feet per person, which may be doubled by applying the 20 square feet per person standard.

Thus, if the more generous standard of 40 square feet per person were applied and compared with estimated populations requiring shelter Monroe County would face a deficit of 5,581 spaces for Monroe County shelters during a Category 1-2 hurricane. This deficiency would be reduced to 71 spaces if the capacity of the existing shelters were calculated based upon the reduced standard of 20 square feet per person. Although this standard has been used in the past, additional site specific data and analyses is needed to confirm the acceptability of applying this reduced standard at each of the available shelters and system-wide. Monroe County must commit to immediately determining the applicability of the 40 square feet per person vs. 20 square feet per person standards and thereby precisely define shelter space deficits. Existing buildings that could serve as shelters must be identified along with actions required to upgrade them to American Red Cross and Emergency Management standards. In addition, all new public buildings suitable for emergency public habitation as determined by the Red Cross should be designed or retrofitted to meet accepted hurricane shelter standards for Category 1-2 hurricanes.

Similarly, the deficit of shelter spaces at FIU available for Monroe County residents ranges from 5,000 to 10,000 spaces depending on whether a 20 square foot per person or a 40 square foot per person is applied. Regardless of which standard applies there remains a sizeable deficit when compared with estimated demand for 14,445 mainland shelter spaces. This deficiency should be addressed through initiation of an interlocal agreement with Dade County and other appropriate agencies such as the Board of Regents to provide additional shelter spaces, preferably by expanding the currently designated shelter facilities or utilizing additional buildings at the University Park campus of FIU. In particular Monroe County should request that FIU identify facilities necessary to meet the deficit and reserve such facilities for Monroe County residents in the FIU campus Master Plan update scheduled to be prepared in 1992 - 93.

E. Other Hurricane Evacuation Needs

Assurance of the safe and orderly evacuation of Monroe County residents and visitors prior to the landfall of a hurricane is dependent upon a number of factors such as proper pre-emergency planning, regulatory mechanisms, and coordinated implementation of the procedures outlined in the Monroe County Hurricane Preparedness Evacuation and Shelter Plan, which should be monitored and updated on an annual basis. Monroe County should consider implementing the following measures to promote safeguarding of the public against the effects of hurricanes and tropical storms:

- (a) Staffing and equipment needs which are directly related to increasing efficiency during hurricane evacuation, such as communications systems, emergency coordination personnel, public education personnel, and development review personnel, should be monitored and priorities established on an annual basis.
- (b) Monroe County should coordinate with the National Oceanic and Atmospheric Administration (NOAA) to install at least four tide gauges at critical locations throughout the Keys in conjunction with the Florida Keys National Marine Sanctuary Program. Such tide gauges would be an invaluable source of information regarding the effects of tropical storms.
- (c) Monroe County should coordinate with other appropriate agencies to draft and implement a comprehensive program to provide for expanded resident and visitor awareness of hurricane evacuation procedures. Operators of transient facilities should be required to notify guests of evacuation procedures during check-in throughout the hurricane season.
- (d) Adoption of Land Development regulations requiring that all new or redeveloped marinas submit hurricane contingency plans as a condition of approval should be considered.
- (e) The establishment of separate dedicated funding sources to allow the Emergency Management and Emergency Communication department to acquire the latest technology available in hurricane analysis and communications systems should be considered.
- (f) The County should consider implementing impact fees to assist in funding acquisition of state of art emergency communications equipment and the creation and/or retrofitting adequate shelter facilities.
- (g) The Post-Disaster Recovery Plan which is currently being prepared by the County should address debris removal preparedness during hurricane evacuation and reentry (see Section 3.22.4).

3.22.2 Coastal High Hazard Area

Rule 9J-5, F.A.C., requires that local governments designate Coastal high Hazard Areas (CHHA) within their jurisdictions. The CHHA is defined to include "areas which have historically

experienced destruction or severe damage, or are scientifically predicted to experience destruction or severe damage, from storm surge, waves, erosion, or other manifestations of rapidly moving or storm driven water” (9J-5.003(14)). The CHHA must include areas designated as Velocity or V zones by Federal Emergency Management Agency (FEMA) (i.e. areas subject to velocity hazard from wave action), the area seaward of the coastal construction control line (CCCL) established by the Florida Department of Natural Resources (DNR), and inlets which are not structurally controlled.

The FEMA-designed V zones are limited to a relatively narrow belt along the shoreline, while the Florida DNR does not generally apply its CCCL standards in Monroe County. Thus an alternative measure of the CHHA is needed in the Florida Keys. The area subject to storm surge impact from a Category 1 hurricane is considered to represent a good approximation of areas predicted to experience destruction or severe damage during storms (Florida Department of Community Affairs, 1991). A Category 1 hurricane is the weakest and has the highest rate of occurrence of the five categories of hurricane intensity as rated on the Saffir-Simpson scale (see Section 3.22.1). As described in Section 3.22.1, the Category 1 storm surge impact area has been scientifically predicted for Monroe County using a computer-generated model referred to as SLOSH (Sea, Lake and Overland Surges from Hurricanes). Therefore, the CHHA in Monroe County is designated as the area subject to inundation by the SLOSH associated with a Category 1 hurricane.

The CHHA in Monroe County is delineated on the Existing Land Use Map Series in the Map Atlas. Because of the low-lying nature of the Keys, approximately 80 percent of the County is located within the CHHA. The area outside of the CHHA is largely confined to a linear zone along much of US 1. Some mostly isolated areas of higher elevation on various keys are also located outside of the CHHA.

3.22.3 Existing Infrastructure within the Coastal High Hazard Area

A. Roadways

US 1, the primary roadway of the Florida Keys, extends the length of Monroe County from the Dade County line to Key West. For most of its length, this roadway is of sufficient elevation to be located out of the CHHA. However, a number of low points are located below 7 feet GVD in elevation and thus are subject to flooding (see Section 3.22.1). In addition, there are 41 bridges totaling 19 miles in length on the unincorporated portion of Monroe County connecting the many keys (see Section 4.2.2 of the Traffic Circulation Element). Although the roadway surface of these bridges is elevated above the CHHA, their support structures are not.

Because of its role as a link between US 1 and outlying residential areas, much of the county road network is located within the CHHA. Card Sound Road, a county road which provides an alternate route to US 1 connecting CR-905 on North Key Largo with the mainland, is characterized by elevations as low as 1.5 feet NGVD. The County road system includes 37 bridges totaling 1.6 miles in length (see Section 4.2.2). The longest of these bridges is the Card Sound Bridge which connects North Key Largo with the mainland.

B. Potable Water Facilities

The primary transmission main connecting the Florida City Wellfield in Dade County with Monroe County runs the length of US 1 to Key west. This main is buried on land and runs along the sides of the bridges connecting the keys. This main is connected to a series of storage and pumping facilities and a separate network of small distribution lines serving developed portions of the Keys, including areas within the CHHA. Recent water main installations have been buried as a means of hazard mitigation. Division 6 (Floodplain Management Standards) of the Monroe County Land Development Regulations requires that new or replacement water supply systems in areas of special flood hazard (the 100-year floodplain, a more extensive area than the CHHA) be installed in accordance with the methods and practices that minimize flood damage (Monroe County BOCC, 1990).

C. Sanitary Sewer Facilities

Because there is no sanitary sewer service in incorporated Monroe County, developed areas within the CHHA are served by privately owned and maintained on-site disposal systems (OSDS), which include septic tank systems and cesspools, and package treatment plants. Division 6 (Floodplain Management Standards) of the Monroe County Land Development Regulations requires that new or replacement sanitary sewer systems installed in areas of special flood hazard be constructed to minimize infiltration of floodwaters into the system and discharge from the system into floodwaters (Monroe County BOCC, 1990).

D. Man-Made Drainage Facilities

For the most part, developed as well as undeveloped portions of Monroe County within the CHHA are not served by man-made drainage facilities. The South Florida Water Management District (SFWMD) has issued permits for residential, commercial, and roadway projects allowing stormwater discharge to the Gulf of Mexico, Florida Bay, and Atlantic Ocean (see Chapter 11.0, Drainage Element).

E. Shore Protection Structures

Public shore protection structures in Monroe County include structures located near bridges and at other locations along US 1 which are maintained by the Florida Department of Transportation. Groins have been constructed at the Bahia Honda State Recreation Area Beach and Coco Plum Beach to control erosion (see Section 3.10.3). Private shoreline structures including riprap and vertical bulkheads have been constructed throughout the Keys, especially along manmade water bodies. Monroe County does not currently permit hardened vertical structures which are damaged beyond repair would be replaced with sloping revetment structures.

Beach and dune erosion and accretion trends including the effects of shore protection structures are discussed in Section 3.10.

3.22.4 Post-Disaster Redevelopment

Post-disaster redevelopment refers to the short- and long-term actions that will be taken to recover from the effects of a natural or man-made disaster which results in extensive damage to property. Planning for post-disaster redevelopment is of paramount importance in Monroe County because a large percentage of the County's land area is located within the CHHA and thus is vulnerable to hurricane damage from a relatively minor (Category 1) hurricane. More intense hurricanes would have higher storm surges and thus would likely inundate a larger area, resulting in even more extensive damage. Closely related to post-disaster redevelopment planning is hazard mitigation, which refers to the implementation of programs prior to the occurrence of a natural or manmade hazard which serve to avoid or reduce the probability of a disaster occurrence (loss of life or property).

A. Existing Land Use in the Coastal High Hazard Area

Because approximately 80 percent of Monroe County is located in the CHHA, existing land use in the CHHA largely reflects existing land uses in the County/. The majority of land within the CHHA is either owned for conservation purposes or is vacant. Much of the existing development in Monroe County is concentrated along US 1 in areas that are located outside of the CHHA. However, a significant portion of the CHHA is developed for a variety of uses including residential (single-family detached homes, mobile homes, multi-family apartments, and mixed-use residential areas), commercial (general commercial, tourist commercial, and commercial fishing), institutional, public, and military uses.

B. Structures with a History of Repeated Damage in Coastal Storms

Because of the number of years since the last occurrence of a major storm in the Keys, the number of structures with a history of repeated damage in coastal storms is limited. Repetitive loss properties are defined by FEMA as properties for which two or more flood insurance claims of at least \$1,000 have been filed since 1978. Only two single -family residential properties, located on Summerland Key and Geiger Key, have been identified by FEMA as repetitive loss areas.

C. Proposed Land Use in the Coastal High Hazard Area

As described in Section 2.4.1 (Future Land Use Concept) of the Future Land Use Element, new development in the CHHA will be limited through implementation of a Permit Allocation and Point System. The Permit Allocation System will limit the overall amount of new residential development permitted in Monroe County (80 percent of which is located in the CHHA) compared to historic growth rates in order to maintain hurricane evacuation clearance times at or below 30 hours. The Point System will direct future growth away from CHHA by assigning a negative point rating to residential and non-residential developments proposed within the CHHA.

D. Hazard Mitigation Measures

A number of hazard mitigation measures are available to local governments to avoid or reduce the probability of a disaster occurrence. The South Florida Regional Planning Council Hurricane Contingency Planning Study (1987) recommends seven "growth management tools for hazard mitigation" which are available to local governments. These tools include the application of land

use plans and zoning, transfer of developments rights (TDR) programs, subdivision regulations, building codes, public facility location planning, public acquisition, and fiscal policies.

Monroe County has in place several hazard mitigation programs. These include regulatory measures such as Floodplain Management Ordinance, public information programs, and participation in the National Flood Insurance Program's Community Rating System. Implementation of additional measures should be considered including growth management policies, stormwater regulations addressing flooding in the CHHA, policies encouraging siting of public infrastructure out of the CHHA, and the consideration of CHHA issues in making public acquisition decisions.

Existing Regulatory Measures

Division 6 of the Monroe County Land Development Regulations, Floodplain Management Standards, regulates development within FEMA-designated "areas of special flood hazard" in order to "protect public health, safety and general welfare and to minimize public and private losses due to flood conditions" (Section 9.5-3.15; Monroe county BOCC, 1990). Areas of special flood hazard identified by FEMA are those inundated by the 100-year flood. These areas, which include the A and the V zones, encompass most of the land area of Monroe County. The Floodplain Management Ordinance sets forth standards for residential and non-residential construction and water supply and sanitary sewer systems within areas of special flood hazard, prohibits the alteration of sand dunes, mangrove stands or wetlands which would increase potential flood damage, and discourages the placement of fill and flood obstructions.

Monroe County currently regulates construction through the Standard Building Code under the Southern Building Code Congress International, Inc. The Floodplain Management Ordinance contains additional standards for residential, non-residential and manufactured (mobile) home development within areas of special flood hazard, including floodproofing requirements, anchoring requirements for mobile homes, and special provisions for construction within V zones. Due to changing technology in the building trade, Monroe County should continue its current policy of periodically reviewing the Building Code and should consider adoption of structural standards and site alteration restrictions that exceed minimum FEMA requirements for flood-prone areas.

Existing Public Information Programs

Monroe County makes available to the public the FEMA flood insurance maps for use in obtaining flood zone information concerning specific properties. In addition, the FEMA coordinator, a staff person in the Growth Management Division, is available to assist members of the public in identifying and implementing flood prevention measures. The Monroe County Extension Service also makes available publications regarding floodplain management. The Floodplain Management Ordinance requires that flood hazard warning be prominently displayed on deeds, leases, and other property sale contracts.

Community Rating System

Monroe County is an active participant in the National Flood Insurance Program's Community rating System (CRS). The CRS provides incentives in the form of lowered flood insurance rates to encourage specific government activities which serve to reduce flood losses, facilitate accurate insurance rating, and promote the awareness of flood insurance in the community. The CRS provides for ten classes with Class 1 having the greatest premium credit and Class 10 having no premium credit. On May 16, 1991, the Federal Insurance Administration announced that 293

communities nationwide, including Monroe County, were designated as the program's first Class 9 communities and would receive a 5 percent reduction in all new or renewed flood insurance policies on or after October 1, 1991. Monroe County is currently implementing measures to further improve its CRS rating.

Additional Hazard Mitigation Measures for Consideration

Section 9.5-343 of the Monroe County Land Development Regulations sets forth requirements for lowered densities of development and increased open space ratios in environmentally sensitive resource areas within the CHHA such as wetlands and beach/berm areas (Monroe County BOCC, 1990). Section 9.5-286 requires that new construction be set back a minimum of 50 feet from natural water bodies with unaltered shorelines and a minimum of 20 feet from manmade water bodies with lawfully altered shorelines (Monroe County BOCC, 1990). These provisions could be strengthened to further lower densities within environmentally sensitive resources within the CHHA and increase setbacks from shoreline areas which are vulnerable to flooding. The existing requirement for 100 percent open space within open waters and mangrove and freshwater wetlands could be extended to apply to undisturbed saltmarsh and buttonwood wetlands. Because the Florida NR does not generally apply its Coastal Construction Control Line standards in the Keys, Monroe County should consider evaluating and revising the existing setback regulations in order to reduce property damage caused by storms.

Because a major (100-year) storm will inundate virtually all of Monroe County, management of floodwaters has not been an issue of major concern in Monroe County. However, it may be possible to decrease property damage resulting from a major storm event by implementing appropriate stormwater management techniques. Section 9.5-293 of the Monroe County Land Development Regulations requires that all new development comply with surface water management criteria (Monroe County, BOCC 1990). The County is currently developing a draft Stormwater Management Ordinance which will include expanded stormwater management criteria applicable to new and existing duplex and single-family homes (see Section 11.0, Drainage Element). The ordinance should discourage filing, impervious surfacing, and other retention of natural drainage patterns and open space.

Monroe County currently has no policies regarding the location of infrastructure out of the CHHA. Such policies would be difficult to implement considering 80 percent of the County is located within the CHHA. As a minimum, public expenditures for new or expanded facilities with the exception of conservation or parkland facilities consistent with natural resource protection could be prohibited in environmentally sensitive areas of the CHHA. Such areas could include areas designated as units of the Coastal Barrier Resource System, undisturbed saltmarsh and buttonwood wetlands, and off-shore islands not currently accessible by road. The Land Development Regulations could be revised to require that alternatives to siting of public facilities and infrastructure in the CHHA be considered where feasible. The development of compatible public uses such as parks and other types of open space should be encouraged within the CHHA while other public facilities such as schools and public buildings should be located out of the CHHA if possible.

Monroe County has no current program for purchasing land within the CHHA. Because approximately 80 percent of the County is located within the CHHA, such a program would be impractical. However, the location of properties within particularly vulnerable areas (e.g., the V

zone) should be considered as a factor in the acquisition of properties for conservation and recreation purposes.

E. Post-Disaster Redevelopment

Immediately following the passage of a hurricane or other disaster occurrence, the focus of governmental agencies shifts from evacuation and shelter to recovery. Post-disaster recovery operations consist of the following three stages:

- (a) immediate safety and damage survey, including assessing the status of the remaining populations;
- (b) immediate repair and cleanup actions and re-entry procedures for the population evacuated from the County; and
- (c) long-term recovery including redevelopment.

During the first stage of post-disaster recovery operations, governmental agencies and utility companies conduct an initial survey of the damaged area to identify immediate safety and health concerns. Movement by the public may be restricted during this period and shelters remain open. Actions taken during this stage include the immediate removal of safety and health hazards and the initiation of search and rescue operations.

During the second stage of post-disaster recovery operations, local, state and federal officials assess damage and the needs of the remaining population, and the marshalling of resources to meet those needs. This stage will likely last from two to five days. During this period, the public may find that little food or other amenities are available and shelters may remain open.

The final stage of post-disaster recovery operations involves long-term rebuilding and redevelopment of damaged properties, a period which could last one year or longer. During this stage, Monroe County will be responsible for the review and permitting of proposed redevelopment.

Planning for the first two stages of post-disaster recovery primarily involves intergovernmental coordination between federal, state and local agencies and interdepartmental coordination within Monroe County government. The state of Florida has in place hurricane coordination procedures which prescribe immediate post disaster actions to be taken as well as procedures for damage assessment and disaster relief. These procedures, which are carried out in coordination with federal and local agencies, are constantly being updated and refined as deficiencies are identified. Examples of such deficiencies which are currently being investigated include prevention and control of post-disaster looters arriving by boat, the staging and availability of equipment for debris removal, and the stockpiling and disposal of debris. Because new issues continually arise and the best methods for addressing such issues may change, annual assessment and coordination of post-disaster is necessary. Such coordination is especially needed to involve agencies which do not normally address disaster preparedness in their day to day operations (e.g., the Florida Department of Environmental Regulation and the Monroe County Public Works Department). The County's Hurricane Preparedness Evacuation and Shelter Plan currently addresses coordination procedures during the period immediately preceding the occurrence of a hurricane. Equivalent coordination

procedures for immediate post-disaster recovery operations should be implemented and reviewed on an annual basis.

Monroe County is currently formulating, with the guidance of the South Florida Regional Planning Council, a Post-Disaster Redevelopment Plan (PDRP) which will address the short- and long-term stages of post-disaster redevelopment. The PDRP will establish goals, Objectives and policies and implementing procedures and programs for 1) immediate repair, replacement, and cleanup operations following a disaster, and 2) long-term rebuilding and redevelopment. The plan will address immediate recovery activities such as search and rescue/fire suppression, emergency law enforcement, damage assessment, temporary housing, relocation of displaced residents, and debris removal. The PDRP will also address the following issues related to long-term post-disaster redevelopment:

- (a) establishment of a post-disaster redevelopment task force to guide implementation of the PDRP;
- (b) establishment of permitting procedures which allow for an orderly process of reviewing private and public redevelopment proposals after a disaster. These procedures should specify coordination mechanisms required to implement permitting procedures (e.g., building inspector and other staff assistance programs) and criteria for distinguishing between minor and major repair and replacement;
- (c) procedures of the identification of damaged infrastructure and consideration of alternatives to its repair or replacement in the CHHA;
- (d) identification of particularly vulnerable areas within the CHHA (e.g., FEMA-designated V zones and repetitive loss areas). Measures should be implemented for such areas which encourage the relocation or replacement of infrastructure away from them and limit redevelopment following occurrence of a hurricane; and
- (e) procedures for the advance identification of redevelopment areas (e.g., any areas identified as being in need of redevelopment pursuant to the Florida Community Redevelopment Act, Chapter 163, Part III) and implementation of redevelopment plans for such areas upon damage or loss due to a natural disaster.

3.23 Public Access Facilities

Public access facilities are those which allow the public access to beach or shoreline. Monroe County's island configuration offers the public a variety of opportunities for physical or visual access to the beach and shoreline.

2.23.1 Existing Public Access Facilities

An inventory of existing facilities which provide public access to the beach or the shoreline is provided in Table 3.31. This table includes marinas, boat ramps, fishing piers, beaches and waterfront parks which are accessible to the public. Private facilities which are available for day use by non-guest or non-residents are also included. The inventory also indicates if parking facilities are

provided. In total, there are over 119 public and private facilities which provide a single or multiple types of public access to the beach or shoreline. The location of these 119 facilities are shown on the Water-Related and Water-Dependent Map series of the Map Atlas. Public access facilities broken down by type of facility and ownership are summarized below:

Table 3.34
Public Access Facilities

	Public	Private	Total
Marinas	3	67	70
Boat Ramps	23	33	56
Fishing Piers	9	-	9
Beaches	8	9	17
Waterfront Parks	13	-	13

Source: Monroe County Growth Management Division, 1991

3.23.2 Coastal Roads and Facilities Providing Scenic Overlooks

A. Overseas Highway

While serving as the County's primary highway and major vehicular link to the mainland, the Overseas Highway (US 1) also serves as one of Monroe County's primary ways of providing public access to the scenery and natural beauty of the Florida Keys. For the most of its 112 miles, stretching from the Dade County Line to Key West, US 1 is within a half mile of Florida Bay or the Atlantic Ocean. The highway includes 42 bridges which provide panoramic views of the water and the Middle and Lower Keys, have small pull-off areas. For the most part, these pull-offs are informal rather than developed viewing areas. However, approaches to Bahia Honda and Long Key State Parks include designated pull-off areas.

B. Old Highway and Railroad Bridges

Along some portions of US 1, the old highway and railroad bridges have been retained as fishing piers and viewing areas. These bridges allow pedestrian access to the water. Public access points are located at:

- a) MM 15 Saddlebunch Key
- b) MM 29 Little Torch Key
- c) MM 33 Big Pine/Spanish Harbor Keys
- d) MM 40 to MM 47 Old Seven Mile Bridge
- e) MM 61 Duck Key
- f) MM 63 Conch Key
- g) MM 71 Long Key
- h) MM 73 Craig Key

3.23.3 Capacity of and Need for Public Access Facilities

The inventory of public access facilities in Table 3.25 (Water dependent uses) provides information on the number and type of existing public access facilities. A capacity analysis for sandy beach included in Section 13.2.4 (Recreation and Open Space Element) determined a surplus of .5 miles of County-owned sandy beach based on the current functional population. However, the County currently lacks information on usage patterns which can be used to determine the capacity of other existing public access facilities. In addition, the County currently has no population-based standards which can be used to project future need for public access facilities. Therefore, the County will complete a public access Plan which will estimate the existing capacity of and need for the following types of public access facilities:

- (a) public access points to the beach or shoreline through public lands;
- (b) public access points to the beach or shoreline through private lands;
- (c) parking facilities for beach or shoreline access;
- (d) coastal roads and facilities providing scenic overlook;
- (e) marinas;
- (f) boat ramps; public docks;
- (g) fishing piers; and
- (h) traditional shoreline fishing areas.

The desired result of the Public Access Plan will be to develop specific population-based standards for each type of public access facility. These standards, applied to future population projections, will provide an estimate of future demand for public access facilities. Based on the results of the plan, the County will adopt Land Development Regulations and implement other measures to provide access to the beach or shoreline consistent with estimated need.

3.24 Existing Infrastructure in the Coastal Area

All of Monroe County is located within the coastal area. Therefore, existing infrastructure in the coastal area is identical to the infrastructure in the following Elements:

- (a) Traffic Circulation (Chapter 4.00);
- (b) Ports, Aviation and related Facilities (Chapter 6.0);
- (c) Potable Water (Chapter 8.0);
- (d) Solid Waste (Chapter 9.0);

- (e) Sanitary Sewer (Chapter 10.0); and
- (f) Drainage (Chapter 11.0).

Bibliography

- Adams, C. 1987. An economic perspective of Florida's changing marine water-dependency. Food and Resource Economics Department, Institute of Food and Agricultural Sciences, University of Florida. Staff Paper 303. 23 pp.
- Alexander, T.R. 1953. Plant succession on Key Largo, Florida involving Pinus caribaea and Quercus virginiana. Quar. Journ. Fla. Acad. Sci. 16(3):133-138.
- Alexander, T. R. and Alan G. Crook. 1974. Recent vegetational changes in south Florida. pp. 61-72 in P.J. Gleason, ed., Environments of South Florida: Present and Past, Miami Geol. Soc. Mem. 2.
- Alexander, T.R. and J.D. Dickson. 1972. Vegetational changes in the National Key Deer Refuge, part II. Quar. Journ. Fla. Acad. Sci. 35:85-96.
- Antoine, J.W. and J.L. Harding. 1963. Structure of the continental shelf of northeastern Gulf of Mexico. Technical Report 63-13T, Department of Oceanography, Texas A&M University, College Station, Texas. 18 pp.
- Antonini, G.A., L. Zobler, H. Tupper, and R. Ryder. 1990. Boat live-aboards in the Florida Keys: A new factor in waterfront development. Florida Sea Grant Report Number 98.
- Applied Biology, Inc. 1985. Key Largo water quality assessment and modeling program, chemical and biological data report. A report to the National Oceanographic and Atmospheric Administration Sanctuary Programs Office.
- Arendt, W.J., T.A. Vargas Mora, and J.W. Wiley. 1979. White-crowned pigeon: status rangewide in the Dominican Republic. Proc. Ann. Conf. S.E. Assoc., Fish and Wildlife Agencies, 33:111-122.
- Avery, G.N. and L.L. Loope. 1980. Endemic taxa in the flora of south Florida. South Florida Research Center Report T-558.
- Bader, R.G., and M.A. Roessler. 1971. An ecological study of South Biscayne Bay and Card Sound. Progress report to the U.S. Atomic Energy Commission (AT(40-1)-3801-3) and Florida Power & Light Company.
- Baggett, H.D. 1982. Schaus' swallowtail. Pp. 73-74 in: Franz, R. (ed.). Rare and endangered biota of Florida, Volume six, Invertebrates. University Presses of Florida, Gainesville, Florida. 131 pp.
- Ballantine, D., and H.J. Humm. 1975. Benthic algae of the Anclote Estuary I. epiphytes of seagrass leaves. Fla. Sci. 38(3):150-162.

- Barbour, D.B., and S.R. Humphrey. 1982. Status and habitat of the Key Largo woodrat and cotton mouse (Neotoma floridana smallii and Peromyscus gossypinus allapaticola). J. Mammol. 63(1):144-148.
- Barbour, T., and G.M. Allen. 1922. The white-tailed deer of eastern United States. J. Mammol. 3:65-78.
- Bicki, T.J., R.B. Brown, M.E. Collins, and R.S. Mansell. 1984. Impact of on-site sewage disposal systems on surface and groundwater quality. Institute of Food and Agricultural Sciences, University of Florida, Gainesville, Florida.
- Birke, L. 1974. Marine blue-green algal mats. in H.T. Odum, B. J. Copeland and E.A. McMahan, eds. Coastal Ecological Systems of the United States. The Conservation Foundation, Washington, D.C. pp. 331-345.
- Browder, J. 1972. Species composition analysis, energy flow model, and discussion of structure and function of a tropical seasonal deciduous forest on Lignum Vitae Key, Florida. Unpublished. 49 pp.
- Brown, L.N. 1978. Key Largo woodrat. Pp. 11-12 in: Layne, J.N. (ed.). Rare and endangered biota of Florida, volume one, Mammals. University Presses of Florida, Gainesville, Florida. 52 pp.
- Brown, B.E. and L.S. Howard. 1985. Assessing the effects of "stress" on reef corals. in J.H.S. Blaxter, F.S. Russell, and M. Yonge, eds. Advances in Marine Biology, Vol. 22. pp. 1-55.
- Burke, D.G., E.J. Meyers, T.W. Tiner, Jr., and H. Groman. 1988. Protecting nontidal wetlands, American Planning Association. 76 pp.
- Burnaman, R. 1991. Letter to Eanix Poole, Chief, Environmental Health Program, Florida Department of Health and Rehabilitative Services, March 7, 1991.
- Camp Dresser & McKee Inc. 1990. Water quality problems and issues in the Florida Keys in Robertson, Mark L. ed., The Florida Keys marine waters and coral reefs strategies for improvement. The Nature Conservancy, Key West, Florida. 35 pp.
- Canter, L.W. and R.C. Knox. 1985. Septic Tank System Effects on Groundwater Quality. Lewis Publishers, Inc., Chelsea, Michigan.
- Carr, A.W., and C.J. Goin. 1955. Reptiles, amphibians and freshwater fishes of Florida. University of Florida, Gainesville, Florida. 341 pp.
- Chester, R.H. 1974. Canal coral survey: Florida Keys. A Report for the Society for Correlation of Progress and Environment.
- CH2M Hill, Inc. 1983. Biological monitoring results, Stock Island Power Plant.

CH2M Hill, Inc. 1979. Monroe County 201 facilities plan. Monroe County, Key West, Florida.

Clark, John R. 1977. Coastal ecosystem management. John Wiley & Sons, New York, New York.

Coastal Technology Corporation. 1987. Shoreline and marina channel renovation alternatives at Bahia Honda State Recreation Area, Monroe County, Florida. Florida Department of Natural Resources, Tallahassee, Florida.

Continental Shelf Associates. 1991. Water quality protection program for the Florida Keys National Marine Sanctuary: Phase 1 report (draft). U.S. Environmental Protection Agency, Atlanta, GA.

Curtis, H. 1977. Invitation to Biology. Worth Publishers, Inc. New York, New York. 646 pp.

de la Cruz, A.A. 1982. The impact of crude oil and oil-related activities on coastal wetlands - A review. Proc. Int. Wetlands Conf., Delhi, India.

D'Elia, C.F., R.W. Buddemeier, and S.V. Smith. 1991. Workshop on coral bleaching, coral reef ecosystems, and global climate change. Miami, Florida.

Deisler, J.E. 1982. Stock Island tree snail. Pp. 8-9 in: Franz, R. (ed.). Rare and endangered biota of Florida, Volume Six, Invertebrates. University Presses of Florida, Gainesville, Florida. 131 pp.

DiSalvo, L.H. and H.T. Odum. 1974. Coral reefs in H.T. Odum, B.J. Copeland, and E.A. McMahan, eds. Coastal Ecological Systems of the United States, Vol. I. pp 372-441.

Dustan, P. and J.C. Halas. 1987. Changes in the reef-coral community of Carysfort Reef, Key Largo, Florida: 1974 to 1982. Coral Reefs 6:91-106.

Emmel, Thomas C. 1986. Status survey and habitat requirements of Florida's endemic Schaus' swallowtail butterfly. Florida Game and Fresh Water Fish Commission, Division of Wildlife, Nongame Wildlife Section, Tallahassee, Florida.

Enos, P. 1977. Quarternary sedimentation in South Florida: part 1 -holocene sediment accumulations of the South Florida Shelf margin. Geol. Soc. Am. Mem. 147:1-130.

Enos, P. and R.D. Perkins. 1979. Evolution of Florida Bay from island stratigraphy. Geol. Soc. Am. Bull., 90(1):59-83.

Ernst, S.H. and R.W. Barbour. 1972. Turtles of the United States. University of Kentucky Press, Lexington, Kentucky. 299 pp.

Evink, G.L. 1981. Hydrological study in the areas of Cross Key, Florida. Florida Department of Transportation, FDOT FL-ER-16-81.

- Federal Emergency Management Agency. 1989. Flood insurance study, Monroe County Florida and incorporated areas. FEMA, Washington, D.C.
- Federal Interagency Committee for Wetland Delineation. 1989. Federal manual for identifying and delineating jurisdictional wetlands. U.S. Army Corps of Engineers, U.S. Environmental Protection Agency, U.S. Fish and Wildlife Service, and U.S.D.A. Soil Conservation Service, Washington, D.C. Cooperative Technical Publication. 76 pp. plus appendices.
- Florida Coastal Resources Interagency Advisory Committee, Florida Keys Subcommittee. 1991. The Florida Keys National Marine Sanctuary Program: an opportunity for state involvement and coordination in resource protection. State of Florida, Tallahassee, Florida.
- Florida Department of Community Affairs. March 1, 1991. Coastal infrastructure policy update, annual report number 6. DCA, Tallahassee, Florida.
- Florida Department of Environmental Regulation. October 25, 1992. Pollutant/test compliance report. DER, Marathon, Florida. 31pp.
- Florida Department of Environmental Regulation. 1991. Groundwater Management System, Report #25.
- Florida Department of Environmental Regulation. 1990a. Allsum 56003 AQSTWIN. DER, Tallahassee, Florida.
- Florida Department of Environmental Regulation. 1990b. Boot Key Harbor study. Preliminary draft manuscript. DER, Marathon, Florida.
- Florida Department of Environmental Regulation. 1989a. Allsum 56003 AQSTWIN. DER, Tallahassee, Florida.
- Florida Department of Environmental Regulation. 1989b. The sites list. DER, Bureau of Waste Cleanup, Tallahassee, Florida.
- Florida Department of Environmental Regulation. 1988a. Allsum 56003 AQSTWIN. DER, Tallahassee, Florida.
- Florida Department of Environmental Regulation. 1988b. Campbell's Marina Study. DER, Marathon, FL.
- Florida Department of Environmental Regulation. 1988c. Florida nonpoint source assessment and management plan: volume I. statewide NPS assessment. DER, Tallahassee, Florida.
- Florida Department of Environmental Regulation. 1987a. Ambient air monitoring report 1987 - air monitoring data report. DER, Tallahassee, Florida.
- Florida Department of Environmental Regulation. 1987b. Ambient air monitoring report 1987 - air quality report. DER, Tallahassee, Florida.

- Florida Department of Environmental Regulation. 1987c. Boot Key Harbor Study. DER, Marathon, FL.
- Florida Department of Environmental Regulation. 1987d. Florida Keys monitoring study, water quality assessment of five selected pollutant sources in Marathon, Florida Keys. DER, Marathon, Florida. 196 pp.
- Florida Department of Environmental Regulation. 1985. Proposed designation of the Waters of the Florida Keys as Outstanding Florida Waters: report to the Environmental Regulation Committee. Tallahassee, Florida. 56 pp. plus appendices.
- Florida Department of Environmental Regulation. 1982. Letter (9-9-82) L. Adair to W. Roberts reviewing Ocean Reef Club phase I data.
- Florida Department of Natural Resources. 1991a. Annual report of the Conservation and Recreation Lands Program. DNR, Tallahassee, Florida.
- Florida Department of Natural Resources. 1991b. Biscayne Bay-Card Sound Aquatic Preserve Management Plan. DNR, Tallahassee, Florida.
- Florida Department of Natural Resources. 1991c Coupon Bight Aquatic Preserve Management Plan. DNR, Florida. 193 pp.
- Florida Department of Natural Resources. 1991d. Lignumvitae Key Aquatic Preserve Management Plan. DNR, Tallahassee, Florida. 156 pp.
- Florida Department of Natural Resources. 1991e. Marine resource issues and research in the Florida Keys. DNR, Tallahassee, Florida.
- Florida Department of Natural Resources. 1990a. Bahia Honda State Park Unit Management Plan. DNR, Tallahassee, Florida
- Florida Department of Natural Resources. 1990b. Carbonate beaches of Florida: an inventory of Monroe County Beaches. DNR, Tallahassee, Florida. 39pp.
- Florida Department of Natural Resources. 1990c. Memorandum on rare and endangered species sightings within state parks of the Florida Keys. (unpublished). DNR, Tallahassee, Florida.
- Florida Department of Natural Resources. 1989a. Investigations on the causes, extent and characteristics of a seagrass die-back in Everglades National Park/Florida Bay, Project proposal. DNR, Tallahassee, Florida. 4 pp.
- Florida Department of Natural Resources. 1989b. Monroe County beach restoration management plan. DNR, Tallahassee, Florida. 39pp.
- Florida Department of Natural Resources. 1977-1982. Summary of Florida commercial marine landings. DNR, Tallahassee, Florida.

- Florida Department of Natural Resources. 1974. Florida Keys coastal zone management study. DNR, Tallahassee, Florida.
- Florida Game and Fresh Water Fish Commission. 1991. Official lists of endangered and potentially endangered fauna and flora in Florida. FGFWFC, Tallahassee, Florida.
- Florida Keys Aqueduct Authority. 1989. Florida Keys Aqueduct Authority policy and procedure handbook. FCAA, Key West, Florida.
- Florida Interagency Management Committee. 1991. The Florida Keys National Marine Sanctuary Program: An opportunity for state involvement and coordination in resource protection. IMC, Tallahassee, Florida.
- Florida State Department of Health. 1963. Monroe County - Florida Keys pollution survey progress report no. 2, November 6, 1962 to April 22, 1963.
- Florida State Department of Health. 1962. Monroe County - Florida Keys pollution survey progress report no. 1, July 24 to September 12, 1962.
- Folk, Klimstra, W.D., and C. Kruer. C. 1990. Key deer accessibility to all of Big Pine Key.
- Garrett, G. and M. Robertson, Eds. 1989. Actions required to insure the viability of Key deer (Odocoileus virginianus clavium). Monroe County Department of Environmental Resources and The Nature Conservancy, Key West, Florida.
- Ginsburg, R.N. 1964. Florida Bay, introduction in R.N
- Ginsburg, ed. South Florida carbonate sediment. The Geological Society of America, Annual Convention. p.11.
- Ginsburg, R.N. 1956. Environmental relationships of grain size and constituent particles in some south Florida carbonate sediments. Bull. Am. Assoc. Petrol. Geol. 40(10):2384-2427.
- Ginsburg, R.N. and H.A. Lowenstam. 1958. The influence of marine bottom communities on the depositional environment of sediments. J. Geol., 66:310-318.
- Glenn, M.E. 1990. Water resources activities in Florida, 1989-90. U.S. Geological Survey, Open-File Report 90-169. 85 pp.
- Glynn, P.W., A.M. Szmant, E.F. Corcoran and S.V. Cofer-Shabica. 1989. Conditions of foral reef Cnidarians from the northern Florida reef tract: pesticides, heavy metals, and histopathological examination. Mar. Poll. Bull., 20:568-576.
- Hanson, C.E. 1980. Freshwater resources of Big Pine Key, Florida. U.S. Geological Survey Open File Report 80-447.

- Hartman, D.S. 1978. West Indian manatee. Pp. 27-30 in: Layne, J.N. (ed.). Rare and endangered biota of Florida, Volume One, Mammals, University Presses, Gainesville, Florida. 52 pp.
- Heiblin, R.J., S. Kent, and D. Lawliss. (no date). Effects of an offshore navigational access channel on the marine benthic community.
- Hoffmeister, J.E. 1974. Land from the Sea. The Geologic Story of South Florida. University of Miami Press, Coral Gables, Florida.
- Hooten, A. 1985. Environmental peer review of Volumes I and II of proposed Florida Keys' comprehensive plan. 87 pp.
- Owe, SE 1988. Lower Keys marsh rabbit status survey. Final report of Florida Game and Fresh Water Fish Commission to Jackson Field Office of the U.S. Fish and Wildlife Service under Cooperative Agreement 14-16-004-87-939. 10 pp.
- Jackson, DR The fauna of freshwater and non-tidal wetlands on Big Pine Key. pp. 37-58 in ML Robertson, J.M. Young eds. Freshwater and Surface Water Resources of Big Pine Key, Monroe County, Florida. 1989. The Nature Conservancy, Key West, Florida. 122 pp.
- Jacobean, Terri. 1983. Crocodilians and islands: status of the American alligator and the American crocodile in the lower Florida Keys. Fla. Field Nat. 11(1):1-24.
- Jape, W.C. 1984. The ecology of the south Florida coral reefs: a community profile. U.S. Fish and Wildlife Service, FWS/OBS-82/08. 138 pp.
- Jape, W.C. 1982. The ecology of the coral reefs of south Florida: a community profile. U.S. Fish and Wildlife Service, Office of Biol. Svc., Washington, D.C. FWS/OBS-82/02.
- Johannes, R.E. 1980. The ecological significance of the submarine discharge of groundwater. Marine Ecology Program Service. 3:365-373.
- Jones, J.A. 1977. Morphology and development of southeastern Florida patch reefs. pp. 231-235 in Proceedings: 3rd International Coral Reef Symposium. Rosenstil School of Marine & Atmospheric Science. University of Miami, Miami, Florida.
- Kaplan, E. 1962. A Field Guide to Coral Reefs of the Caribbean and Florida Including Bermuda and the Bahamas. Houghton Mifflin Company, Boston. 289 pp.
- Kikuchi, T. 1980. Faunal relationships in temperate seagrass beds. in R.C. Phillips and C.P. McRoy, eds. Handbook of Seagrass Biology: An Ecosystem Perspective. pp. 153-172.
- King, W., and T. Krakauer. 1966. The exotic herpetofauna of southeastern Florida. Quart. J. Florida Acad. Sci. 29:149-154.
- King, W., and T. Krakauer. 1968. The ecology of the neotropical toad, Bufo marinus, in south Florida. Herptological 24:214-221.

- Kissling, D.L. 1977. Coral reefs in the lower Florida Keys: a preliminary report. pp. 209-215 in H.G. Multer, ed. Field Guide to some carbonate rock environments: Florida Keys and western Bahamas. Kendall/Hunt Publ. Co., Fla. U.S.G.S. Open File Report 70-010.
- Klein, H. 1970. Preliminary evaluation of availability of potable water on Elliott Key, Dade County, Florida. U.S. Geological Survey, Open File Report 70010.
- Kochman, H.I. 1978. Eastern indigo snake. Pp. 68-69 in: McDiarmid, R.W.(ed.) Rare and endangered biota of FLorida, Volume Three, Amphibians and Reptiles. University Presses of Florida, Gainesville, Florida. 74 pp.
- Krakauer, T. 1970. The invasion of the toads. Fl. Nat. 44:12-14.
- Kreur, C. 1991. Draft assessment of Florida's remaining coastal upland natural communities. Florida Natural Areas Inventory, Tallahassee, Florida.
- Kruer, C. 1990. Program to address boating related human and environmental impacts in the Florida Keys. Florida Keys Audubon Society, Conservation Committee, Marathon, Florida. 6 pp.
- Kushlan, J.A. 1979. Feeding ecology and prey selection in the white ibis. Condor, 81:376-389.
- Kushlan, J.A., J.C. Ogden and A.L. Higer. 1975. Relation of water level and fish availability to wood stork reproduction in the southern Everglades, Florida. U.S. Dept. of the Interior, Geological Survey. Open File Report 75-434. Tallahassee, Florida. 56 pp.
- Lane, Ed. 1986. Geology of the state parks in the Florida Keys. Florida Geological Survey Leaflet No. 14, Florida Geological Survey, Tallahassee, Florida.
- Lane, Ed. 1981. Environmental Geology Series - Miami Sheet. Florida Geological Survey Map Series 101, Florida Geological Survey, Tallahassee, Florida.
- Lapointe, B.E. 1989a. Macroalgal production and nutrient relations in oligotrophic areas of Florida Bay. Bull. Mar. Sci 44(1):312-323.
- Lapointe, B.E. 1989b. Pollution of Ground Waters and Surface Waters of Big Pine Key. pp. 100-116 in M. L. Robertson, J.M. Young eds. 1989. Freshwater and Surface Water Resources of Big Pine Key, Monroe County, Florida. The Nature Conservancy, Key West, Florida. 122 pp.
- Lapointe, B.E., and M.W. Clark. 1990a. Final report. spatial and temporal variability in trophic state of surface waters in Monroe County during 1989-1990. Florida Keys Land and Sea Trust, Marathon, Florida. 81 pp.
- Lapointe, B.E., J.D. O'Connell, and G.S. Garrett. 1990b. The effects on on-site sewage disposal systems on nutrient relations of groundwaters and nearshore surface waters of the Florida Keys. Biogeochemistry. 10:289-307.

- Lapointe, B.E., M.M. Littler, and D.S. Littler. 1987. A comparison of nutrient-limited productivity in macroalgae from a Caribbean barrier reef and from a mangrove ecosystem. *Aquatic Botany*. 28:243-255.
- Layne, J.N. 1974. The land mammals of South Florida. Miami, Geol. Soc. Mem 2:386-413.
- Lazell, J.D. 1989. Wildlife of the Florida Keys: A Natural History. Island Press, Washington, D.C. 253 pp.
- Lazell, J.D. 1984. A new marsh rabbit (Sylvilagus palustris) from Florida's Lower Keys. *J. Mamm.* 65(1):26-33.
- Lee, T.N. 1975. Circulation and exchange processes in southeast Florida's coastal lagoons. Technical Report, University of Miami, Rosenstiel School of Marine and Atmospheric Science.
- Lewis, R.R., III. 1980. Impacts of oil spills on mangrove forests. p.36 in 2nd Int. Symp. Biol. Manage. Mangroves Trop. Shallow Water Communities, Port Moresby, Madang, Papua New Guinea.
- Lloyd, Jacqueline M. 1991. Part 1: 1988 and 1989 Florida petroleum production and exploration. Florida Geological Survey Information Circular No. 107, Florida Geological Survey, Tallahassee, Florida.
- Loftus, W.F. and J.A. Kushlan. 1982. The status of the Schaus' swallowtail and the Bahama swallowtail butterflies in Biscayne National Park. South Florida Research Center Report M-649. 18 pp.
- Lugo, A.E. and S.C. Snedaker. 1974. The ecology of mangroves. *Ann Rev. Ecol. Stst.* 5:39-64.
- Lund, F. 1978. Atlantic hawksbill. Pp.24-25 in: McDiarmid, R.W.(ed.). Rare and endangered biota of Florida, Volume Three, Amphibians and reptiles. University Presses of Florida, Gainesville, Florida. 74 pp.
- Lund, F. 1978. Atlantic leatherback. Pp.54-55 in: McDiarmid, R.W.(ed.). Rare and endangered biota of Florida, Volume Three, Amphibians and reptiles. University Presses of Florida, Gainesville, Florida. 74 pp.
- Lund, F. 1978. Atlantic loggerhead. Pp.35-36 in: McDiarmid, R.W.(ed.). Rare and endangered biota of Florida, Volume Three, Amphibians and reptiles. University Presses of Florida, Gainesville, Florida. 74 pp.
- Lyons, William G. 1986. Problems and perspective regarding recruitment of spiny lobsters, Panulirus argus, to the South Florida fishery. *Can. J. Fish. Aquat. Sci.*, Vol. 43.
- McCallum, J.S. and K.W. Stockman. 1964. Florida Bay: water circulation, in R.N. Ginsburg, ed. South Florida carbonate sediments. The Geological Society of America. pp.11-13.

- McGill, J.T. 1959. Coastal Classification Maps. pp.1-22 in R.J. Russell, ed. Second Coastal Geography Conference. Coastal Studies Inst., Louisiana State University, Baton Rouge Louisiana.
- McNulty, J.K. 1970. Studies in tropical oceanography No. 9: effects of abatement of domestic sewage pollution on the benthos, volumes of zooplankton, and the fouling organisms of Biscayne Bay, Florida. Stud. Trop. Oceanogr. Inst. Mar. Atmos. Sci. Univ. Miami. Miami, Florida. 107 pp.
- Magley, K. 1982. Nu-Age Utility Sewage Treatment Plant intensive survey documentation. Florida Department of Environmental Regulation, WQTS Vol. 1 No. 61.
- Marszelak, D.S. 1984. Florida reef tract marine habitats and ecosystems (map series, 1:30,000 scale). Rosenstiel School of Marine and Atmospheric Sciences, University of Miami, Miami, Florida, and U.S. Dept. Interior, Minerals Management Service, New Orleans, Louisiana.
- Marszelak, D.S., G. Babashoff, M.R. Noel and D.R. Worley. 1977. Reef distribution in South Florida. pp. 223-230 in D.L. Taylor, ed. Proceedings: 3rd International Coral Reef Symposium, Vol. 2. Rosenstiel School of Marine and Atmospheric Science. University of Miami, Miami, Florida.
- Maturo, F.J., and Caldwell, J.W. 1982. Turbidity and biological communities annual technical report, Florida Keys. Florida DOT, FDOT FL-ER-18-82.
- Merchant, Randy and J. Habersfeld. 1988. Memorandum: Characterization of secondarily treated domestic sewage disposed of via class V injection wells (boreholes) in the Florida Keys. DER, Marathon, FL.
- Merriam, D.F. 1989 (abstract). Overview of the geology of Florida Bay, review of recent developments. Bull. Mar. Sci. 44(1):519. Presented at Symposium on Florida Bay, a Subtropical Lagoon. U.S. National Park Service/Everglades National Park and University of Miami Rosenstiel School of Marine and Atmospheric Science. 1-5 June 1987.
- Miller, J. 1988. Results of a workshop on coral reef research and management in the Florida Keys: a blueprint for action. National Undersea Research Program Research report 88-5. U.S. Department of Commerce, NOAA, Washington, D.C. 49 pp.
- Monroe County Board of County Commissioners. 1991a. Comprehensive plan preliminary policy direction. Monroe County BOCC, Key West, Florida. 52 pp.
- Monroe County Board of County Commissioners. 1991b. Letter from the BOCC to the Florida Marine Fisheries Commission (dated December 3, 1991). Monroe County BOCC, Key West, Florida.
- Monroe County Board of County Commissioners. 1990. Land development regulations. Monroe County BOCC, Key West, Florida.

- Monroe County Building Department. 1990. Unpublished list of permitted resource extraction activities. Monroe County Building Department, Key West, Florida.
- Monroe County Civil Defense. 1985. Monroe County peacetime emergency plan, annex V: evacuation. Monroe County Civil Defense, Key West, Florida.
- Monroe County Department of Emergency Management. 1991. Monroe County hurricane preparedness evacuation and shelter plan. Monroe County Department of Emergency Management, Key West, Florida.
- Monroe County Department of Environmental Resources. 1991. Florida Keys Advance Identification Project draft scope of work. Monroe County Dept. of Environmental Resources, Key West, Florida.
- Monroe County Department of Environmental Resources. 1990. Synopsis of the policy decisions made by the Planning Commission on 14, 21, and 28 June, and 2 July 1990, concerning the Big Pine Area of Critical County Concern. Monroe County Dept. of Environmental Resources, Key West, Florida.
- Monroe County Department of Environmental Resources. 1989. Checklist of the plants of the Florida Keys. Monroe County Environmental Resources Department, Key West Florida.
- Monroe County Department of Marine Resources. 1991. Monroe County Department of Marine Resources mission statement FY 1991-1992 with detailed delineation and assessment of administrative responsibilities. Monroe County, Key West, FL. 5 pp.
- Monroe County Department of Planning. 1991a. Inventory of subdivisions zoned IS, URM and CFV (unpublished). Monroe County Division of Growth Management, Key West, FL.
- Monroe County Department of Planning. 1991b. Monroe County Comprehensive Plan, Technical Report. Monroe County, Key West, FL.
- Monroe County Department of Planning. 1989. North Key Largo habitat conservation plan. Monroe County Planning Department, Key West Florida.
- Monroe County Department of Planning. 1986a. Florida Keys' comprehensive plan, volume I. Background data element. Monroe County, Key West, FL. 583 pp.
- Monroe County Department of Planning. 1986b. Florida Keys' comprehensive plan, volume II. Analysis and policy element. Monroe County, Key West, FL. 243 pp.
- Morris, F.W. 1981. Residential canals and canal networks: design and evaluation. Florida Sea Grant College, Report Number 43. 151 pp.
- Multer, H.G. 1977. Field Guide to Some Carbonate Rock Environments, Florida Keys and Western Bahamas. Kendall/Hunt Publ. Co., Dubuque, Iowa. 415 pp.

- Nelson, Carnot E., Carol Crumley, Barbara Fritzsche, and Brian Adcock. October 1989. Behavioral analysis in lower southeast Florida hurricane evacuation study update. U.S. Army Corps of Engineers, Jacksonville, Florida.
- Nnaji, S. 1987. South Biscayne Bay water quality: A twelve year record for Biscayne National Park. A report for the Biscayne National Park, National Park Service, U.S. Department of the Interior. 79 pp.
- Odum, W.E. and C.C. McIvor. 1990. Mangroves. Pp. 517-548 in Myers, R.L., and J.J. Ewel (eds.), Ecosystems of Florida. University of Florida Press, Gainesville, Florida.
- Odum, W.E., C.C. McIvor, T.J. Smith, III. 1982. The ecology of the mangroves of south Florida: a community profile. U.S. Fish and Wildlife Service, Office of Biological Services, Washington, D.C. FWS/OBS-81/24. 144 pp.
- Ogden, J.C. 1978a. American crocodile. Pp. 21-2 in: McDiamid, R.W. (ed.). Rare and endangered biota of Florida, Volume Three, Amphibians and reptiles. University Presses of Florida, Gainesville, Florida. 74 pp.
- Ogden, J.C. 1978b. Status and nesting biology of the American crocodile, Crocodylus acutus, (Reptilia, Crocodylidae) in Florida. J. Herpetol 12(2):183-196.
- Ogden, J.C. 1978c. Wood Stork. Pp. 3-4 in: Kale, H.W. II (ed.). Rare and endangered biota of Florida, Volume Two, Birds, University Presses of Florida, Gainesville, Florida. 121 pp.
- Ogden, J.C., J.A. Kushlan and J.T. Tilmant. 1978. The food habitats and nesting success of wood storks in Everglades National Park 1974. U.S. Dept. of the Interior, National Park Service Natural Resources Rpt. No. 16, Washington, D.C. 25pp.
- Olmstead I.D., and L.L. Loope. 1984. Plant communities of Everglades National Park. p. 167-184 in Gleason, P.J. ed., 1984. Environments of South Florida, Present and Past II. Miami Geol. Soc., Coral Gables, Florida.
- Owre, O.T. 1978. White-crowned pigeon. Pp. 43-45 in: Kale, H.W. II (ed.). Rare and endangered biota of Florida, Volume Two, Birds. University Presses of Florida, Gainesville, FL. 121 pp.
- Post, Buckley, Schuh & Jernigan, Inc. December 1991. Technical memorandum: Monroe County comprehensive plan hurricane evacuation analysis. P.B.S.J., Tallahassee, Florida.
- Raymond, P.W. 1984. Sea turtle hatchling disorientation and artificial beachfront lighting: a review of the problem and potential solutions. The Center for Environmental Education, Washington, D.C. 72 pp.
- Reed, P.B. 1988. National list of plant species that occur in wetlands: Florida. U.S. Fish and Wildlife Service NERC-88/18.09, Washington, D.C. 22 pp. plus plant lists.

- Robblee, M.B., T.R. Barber, P.R. Carlson, M.J. Durako, J.W. Fourqurean, L.K. Muehlstein, D. Porter, L.A. Yarbrow, R.T. Zieman, and J.C. Zieman. 1991. Mass mortality of the tropical seagrass Thalassia testudinum in Florida Bay (USA). *Mar. Ecol. Prog. Ser.* 71:297-299.
- Robertson, Mark L. 1990. The Florida Keys marine waters and coral reefs strategies for improvements, volume I: executive summary. The Nature Conservancy, Key West, Florida. 10 pp.
- Robertson, Mark L. 1955. An analysis of the breeding bird populations of tropical Florida in relation to the vegetation. PhD. thesis, Univ. Illinois.
- Robertson, Mark L., and Jora M. Young, eds. 1989. Freshwater and surface water resources of Big Pine Key, Monroe County, Florida. The Nature Conservancy, Key West, Florida. 122 pp.
- Robertson, W.B. Jr. 1878a. Roseate tern. Pp. 39-40 in: Kale, H.W.II (ed.). Rare and endangered biota of Florida, Volume Two, Birds. University Presses of Florida, Gainesville, FL. 121 pp.
- Robertson, W.B. Jr. 1878b. Southern bald eagle. Pp. 27-30 in: Kale, H.W.II (ed.). Rare and endangered biota of Florida, Volume Two, Birds. University Presses of Florida, Gainesville, FL. 121 pp.
- Rosenau, et al. 1977. Springs of Florida. Florida Department of Natural Resources, Bureau of Geology. Bulletin #31 revised.
- Ross, M.S. 1989. Effects of hydrologic factors on the vegetation of Big Pine Key. pp. 29-36 in M.L. Robertson, J.M. Young eds. 1989. Freshwater and Surface Water Resources of Big Pine Key, Monroe County, Florida. The Nature Conservancy, Key West, Florida. 122 pp.
- Saarinen, Arthur W., Jr. 1989. The use of septic systems and their effects on the freshwater resources on Big Pine Key. pp. 59-99 in M.L. Robertson, J.M. Young eds. 1989. Freshwater and Surface Water Resources of Big Pine Key, Monroe County, Florida. The Nature Conservancy, Key West, Florida. 122 pp.
- Schmidt, T.W. and G.E. Davis. 1978. A summary of estuarine and marine water quality information collected in Everglades National Park, Biscayne National Monument and adjacent estuaries from 1879 to 1977. Report Number T-519. National Park Service, South Florida Research Center, Homestead, Florida. 79 pp.
- Schomer, N.S. 1979. Memo (6-25-79) R. Armstrong to P. Edwards, on wasteload allocations.
- Schomer, N.S., and R.D. Drew. 1982. An ecological characterization of the Lower Everglades, Florida Bay and the Florida Keys. U.S. Fish and Wildlife Service, Office of Biological Services, Washington, D.C. FWS/OBS-82.58.1.
- Schroeder, P.B. 1987. Habitat evaluation indices for the Florida Keys. Monroe County Planning Department, Key West, Florida. 44 pp.

- Schwartz, A. 1952. The land mammals of southern Florida and upper Florida Keys. Unpubl. dissert., Univ. Michigan, Ann Arbor, Michigan. 180 pp.
- Scoffin, T.P. 1970. The trapping and binding of subtidal carbonate sediments by marine vegetation in Bimini Lagoon, Bahamas. *J. Sediment Petrol.* 40(1):249-273.
- Silvy, N.J. 1975. Population density, movements and habitat utilization of Key deer, Odocoileus virginianus clavium. PhD. dissert., Southern Illinois Univ., Carbondale, Illinois. 152 pp.
- Simberloff, D., and E.O. Wilson. 1969. Experimental zoogeography of islands: the colonization of empty islands. *Ecology* 50:278-296.
- Skinner, R.H. and E.F. Corcoran. 1989. John Pennekamp Coral Reef State Park water quality monitoring program, assessment of water quality data from five stations, Volume 1. A report for Florida Department of Natural Resources. 47 pp.
- Skinner, R.H. and W.C.Jaap. 1986. Trace metal and pesticides in sediments and organisms in John Pennekamp Coral Reef State Park and Key Largo Natural Marine Sanctuary. Report to the Florida Department of Environmental Regulation Coastal Zone Management Office.
- Smith, S.V., W.J. Kimmerer, E.A. Laws, R.E. Brock, and T.W. Walsh. 1981. Kaneohe Bay sewage diversion experiment: perspectives on ecosystem responses to nutritional perturbation. *Pac. Sci.* 35:279-395.
- Snedaker, S.C. 1990. Water quality problems and issues in the Florida Keys in Robertson, Mark L. ed., *The Florida Keys marine waters and coral reefs strategies for improvement*. The Nature Conservancy, Key West, Florida. 35 pp.
- Snyder, H. 1978. Peregrine Falcon. Pp. 8-9 in: Kale, H.W.II (ed.). *Rare and endangered biota of Florida, Volume Two, Birds*. University Presses of Florida, Gainesville, FL. 121 pp.
- South Florida Regional Planning Council. December 1990. Post disaster redevelopment planning: model plans for three florida scenarios. SFRPC, Hollywood, Florida.
- South Florida Regional Planning Council. 1987. Hurricane contingency planning study. SFRPC, Hollywood, Florida.
- South Florida Water Management District. 1991. Final draft surface water improvement and management plan for the Everglades, volumes I, II, III, IV, appendices A-D. South Florida Water Management District, South Palm Beach, Florida.
- South Florida Water Mangement District. 1989. Surface water improvement and management (SWIM) plan for Biscayne Bay. SFWMD, South Palm Beach, Florida.
- Southern Illinois University, Cooperative Wildlife Research Lab. (no date). "Big Pine Key Fresh Water and Nontidal Wetlands". Southern Illinois University, Carbondale, Illinois.

- Spitzer, N.C. 1983. Aspects of the biology of the silver rice rat Oryzomys argentatus. Unpubl. M.S. Thesis, Univ. of Rhode Island, Kingston, 101.pp.
- Spitzer, Numi C. and James D. Lazell, Jr. 1978. A new rice rat (genus oryzomys) from Florida's Lower Keys. J. Mammol., 59(4):787-792.
- Steiner, T.M., O.L. Bass, Jr. and J.A. Kushlan. 1983. Status of the eastern indigo snake in southern Florida national parks and vicinity. So. Fla. Cntr. (Everglades National Park), Report #SFRC-83/01. 25pp.
- Stewart, M.T., M.J. Wightman and K.M. Beaudoin. 1989. The freshwater lenses of Big Pine Key. in M.L. Robertson, J.M. Yound eds. 1989. Freshwater and Surface Water Resources of Big Pine Key, Monroe County, FLorida. The Nature Conservancy, Key West, Florida. 122 pp.
- Stout, J. 1984. The ecology of irregularly flooded salt marshes of the northeastern Gulf of Mexico: a community profile. U.S. Fish and Wildlife Service, Biological Report 85(7.1), Washington, D.C. 98 pp.
- Szmandt, A.M. 1991. Inshore-offshore patterns of nutrient and chlorophyll concentration along the Florida Reef Tract, p.42-62. In: SEAKEYS Phase I, Sustained Ecological Research Related to Management of the Florida Keys Seascape. A final report to the John D. and Catherine T. MacArthur Foundation World Environment and Resources Program from the Florida Institute of Oceanography, St. Petersburg, FL.
- Tabb, D.C. 1967. Prediction of estuarine salinities in Everglades National Park, Florida, by the use of ground water records. PhD. dissertation, University of Miami, Coral Gables, Florida.
- Teas, H. and J. Kelly. 1975. Effects of herbicides on mangroves of S. Vietnam and Florida. Pp. 719-728 in Walsh, G., S. Snedaker, and H. Teas (Eds.), Proc. Int. Symp. Biol. Manage. Mangroves, University of Florida, Gainesville, Florida.
- Tetra Tech, Inc. 1983. Ecological impacts of sewage discharges on coral reef communities. U.S. Environmental Protection Agency 420-9-83-010, Washington, D.C. 85 pp.
- The Nature Conservancy. 1990. The Florida Keys marine waters and coral reefs: strategies for improvement, volumes I and II. The Nature Conservancy, Key West, Florida.
- The Nature Conservancy. 1989. Freshwater and Surface Water Resources of Big Pine Key, Monroe County, Florida. (Mark L. Robertson and Jora M. Young, eds.) The Nature Conservancy, Key West, Florida.
- The Nature Conservancy. (no date). Hammocks of the Lower Keys - a proposal to: Conservation and Recreational Lands, State of Florida Department of Natural Resources. The Nature Conservancy, Key West, Florida.
- Thomas, T.M. 1974. A detailed analysis of climatological and hydrological records of south Florida with reference to man's influence upon ecosystem evolution in Gleason, P.J. ed.,

- Environments of South Florida: Present and Past. Miami Geological Society, Miami, Florida, pp. 82-122.
- Tilmant, J.T. 1989. Foreword (symposium on Florida Bay, a subtropical lagoon). *Bull. Mar. Sci.* 44(1):1-2.
- Titus, J.G. 1988. Sea level rise, in J.B. Smith and D. Tirpak, eds. *The Potential Effects of Global Climate Change on the United States*. U.S. Environmental Protection Agency, Washington, D.C. pp. 9.6-9.47.
- Titus, J.G. 1988. Sea level rise and wetland loss: an overview in J.G. Titus, ed. *Greenhouse Effect, Sea Level Rise and Coastal Wetlands*. U.S. Environmental Protection Agency, EPA-230-05-86-013. Washington, D.C. pp.1-33.
- Tomlinson, P.B. 1980. The Biology of Trees Native to Tropical Florida. Maria Moors Cabot Foundation for Botanical Research and Atkins Garden Fund of Harvard University. 480 pp.
- Turney, W.J. and B.F. Perkins. 1972. *Sedimenta III: Molluscan distribution in Florida Bay*. Comparative Sedimentology Laboratory, University of Miami, Rosenstiel School of Marine and Atmospheric Science, Miami, Florida. 37 pp.
- U.S. Army Corps of Engineers. June 1991. Lower southeast Florida hurricane evacuation study update. U.S.C.O.E., Jacksonville, Florida.
- U.S. Department of Agriculture, Soil Conservation Service. September 15, 1991. Letter from the District Conservationist for Dade-Monroe Counties to the Monroe County Growth Management Division (Re: Monroe County Soil Erosion). U.S.D.A., S.C.S., Homestead, Florida.
- U.S. Department of Agriculture, Soil Conservation Service. 1989. Classification and correlation of the soils of Monroe County Keys area Florida. U.S.D.A., S.C.S., Gainesville, Florida.
- U.S. Department of Agriculture, Soil Conservation Service. 1978. Water and wind erosion control handbook - Florida. U.S.D.A., SCS, Gainesville, Florida.
- U.S. Department of Commerce, National Oceanic and Atmospheric Administration and the University of Miami Rosenstiel School of Marine and Atmospheric Science. 1991. Draft report on the research planning workshop for the Florida Keys National Marine Sanctuary. NOAA, Rockville, Maryland.
- U.S. Department of Commerce, National Oceanic and Atmospheric Administration. 1988. Results of a workshop on coral reef research and management in the Florida Keys: A blueprint for action. NOAA, Rockville, Maryland.
- U.S. Department of Commerce, National Oceanic and Atmospheric Administration. (no date). A storm surge atlas for the Florida Bay area. NOAA, National Hurricane Center, Coral Gables, Florida.

- U.S. Department of the Interior. 1989. Big Cypress National Preserve draft general management plan and draft environmental impact statement. U.S. Fish and Wildlife Service, Atlanta, Georgia.
- U.S. Department of the Interior, Coastal Barriers Study Group. 1988. Executive summary in Report to Congress: Coastal Barrier Resources System. U.S. Department of the Interior, Washington, D.C. 27 pp.
- U.S. Department of the Interior, National Marine Fisheries. 1984-1989. Commercial fishing landings (unpublished data). Key West, Florida.
- U.S. Department of the Interior. 1983. Final land protection plan: Crocodile Lake National Wildlife Refuge, Monroe County, Florida. U.S. Fish and Wildlife Service. 22 pp. plus appendices.
- U.S. Environmental Protection Agency. 1991a. Florida Keys advance identification of wetlands program: draft scope of work for the Florida Keys wetlands.
- U.S. Environmental Protection Agency. 1991b. Monitoring Discharge Reports.
- U.S. Environmental Protection Agency. 1991c. List of active NPDES permits, Monroe County, Florida, October 1991.
- U.S. Environmental Protection Agency. 1989. Fact sheet: advance identification of wetlands program. 5 pp.
- U.S. Environmental Protection Agency. 1975. Fingerfill canal studies, Florida and North Carolina. Report EPA-904/9-76-017. Surveillance and Analysis Section, U.S. EPA. Athens, Georgia. 427 pp.
- U.S. Environmental Protection Agency. (date unknown). Hazardous waste assessments, Monroe County, Florida, Component two: Identification of abandoned dump sites. 16 pp.
- U.S. Fish and Wildlife Service. 1991a. Final land protection plan for the establishment of deer movement corridors National Key Deer Refuge, Monroe County, Florida. U.S. Fish and Wildlife Service, Atlanta, Georgia. 34 pp.
- U.S. Fish and Wildlife Service. 1991b. National Key Deer Refuge final environmental impact assessment and land protection plan for the establishment of deer movement corridors. U.S. Fish and Wildlife Service, Atlanta, Georgia. 32 pp.
- U.S. Fish and Wildlife Service. 1989a. Endangered and threatened wildlife and plants: proposed endangered status for the Lower Keys rabbit and threatened status for the Squirrel Chimney cave shrimp. Fed.Reg. 54(167):35905-35907.
- U.S. Fish and Wildlife Service. 1989b. Florida manatee (Trichechus manatus latirostris) recovery plan. U.S. Fish and Wildlife Service, Atlanta, Georgia. 160 pp.

- U.S. Fish and Wildlife Service. 1989c. Southeastern population roseate tern recovery plan. U.S. Fish and Wildlife Service, Atlanta, Georgia.
- U.S. Fish and Wildlife Service. 1989d. Southeastern states bald eagle recovery plan. U.S. Fish and Wildlife Service, Atlanta, Georgia. 160 pp.
- U.S. Fish and Wildlife Service. 1988a. Atlantic coast piping plover recovery plan. U.S. Fish and Wildlife Service, Atlanta, Georgia. 77 pp.
- U.S. Fish and Wildlife Service. 1988b. Recovery plan for five Florida pine rockland plant species. U.S. Fish and Wildlife Service, Atlanta, Georgia. 18 pp.
- U.S. Fish and Wildlife Service. 1986a. Key tree-cactus recovery plan. U.S. Fish and Wildlife Service, Atlanta, Georgia. 28 pp.
- U.S. Fish and Wildlife Service. 1986b. Recovery plan for the U.S. breeding population of the wood stork. U.S. Fish and Wildlife Service, Atlanta, Georgia. 28 pp.
- U.S. Fish and Wildlife Service. 1985. Florida Key deer recovery plan (revision). U.S. Fish and Wildlife Service, Atlanta, Georgia. 46 pp.
- U.S. Fish and Wildlife Service. 1984a. American crocodile recovery plan. U.S. Fish and Wildlife Service, Atlanta, Georgia. 37 pp.
- U.S. Fish and Wildlife Service. 1984b. Marine turtle recovery plan. U.S. Fish and Wildlife Service, Atlanta, Georgia. 366 pp.
- U.S. Fish and Wildlife Service. 1983. Crocodile Lake National Wildlife Refuge final land protection plan. U.S. Fish and Wildlife Service, Atlanta, Georgia.
- U.S. Fish and Wildlife Service. 1982a. Eastern indigo snake recovery plan. U.S. Fish and Wildlife Service, Atlanta, Georgia. 23 pp.
- U.S. Fish and Wildlife Service. 1982b. Schaus' swallowtail butterfly recovery plan. U.S. Fish and Wildlife Service, Atlanta, Georgia. 57 pp.
- U.S. Fish and Wildlife Service. 1982c. Stock Island tree snail recovery plan. U.S. Fish and Wildlife Service, Atlanta, Georgia. 15 pp.
- U.S. Fish and Wildlife Service. 1979a. Eastern peregrine falcon recovery plan. U.S. Fish and Wildlife Service, Atlanta, Georgia. 147 pp.
- U.S. Fish and Wildlife Service. 1979b. Loggerhead sea turtle. U.S. Fish and Wildlife Service, Atlanta, Georgia. (unpublished mimeo) 3 pp.
- U.S. Fish and Wildlife Service. 1977. Leatherback turtle. U.S. Fish and Wildlife Service, Atlanta, Georgia. (unpublished mimeo) 4 pp.

- U.S. Fish and Wildlife Service. 1985. Florida Key deer recovery plan. U.S. Fish and Wildlife Service, Atlanta, Georgia. 46 pp.
- U.S. Fish and Wildlife Service. 1984. American crocodile recovery plan. U.S. Fish and Wildlife Service, Atlanta, Georgia. 37 pp.
- U.S. Fish and Wildlife Service. 1980. Florida Key deer recovery plan. U.S. Fish and Wildlife Service, Atlanta, Georgia. 52 pp.
- Wanless, H. 1989. The inundation of our coastlines. *Sea Frontiers*, Sept.- Oct. 1989.
- Weiner, A.H. 1979. The hardwood hammocks of the Florida Keys: an ecological study. National Audubon Society and Florida Keys Land and Sea Trust. Key West, Florida.
- Wiley, J.W. and B.N. Wiley. 1979. The biology of the white-crowned pigeon. *Wildl. Monogr.* No. 64. 54 pp.
- Wiley, J.W. 1979. The white-crowned pigeon in Puerto Rico: status, distribution and movements. *J. Wildl. Manage.*, 43(2):402-413.
- Zieman, J.C. 1982. The ecology of the seagrasses of south Florida: a community profile. U.S. Fish and Wildlife Service, Office of Biological Services, Washington, D.C. FWS/OBS-82/25. 158 pp.
- Zieman, J.C. 1975. Tropical seagrass ecosystems and pollution. Chapter 4 in E.J.F. Wood and R.E. Johannes, eds. *Tropical marine pollution* Elsevier Oceanography Series 12. Elsevier Publ. Co., New York, New York.
- Zieman, J.C. 1974. The ecological effects of motor boats on turtle grass beds in Everglades National Park, a report to the National Park Service. 23 pp.
- Zieman, J.C. 1972. Origin of circular beds of *Thalassia* (Spermatophyta: Hydrocharitaceae) in South Biscayne Bay, Florida, and their relationship to mangrove hammocks. *Bull. Mar. Sci.* 22(3):559-574.